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TECH TALES

RYZEN FROM THE GRAVE

How AMD recovered from oblivion

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WINDOWS 11

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EDITORIAL

WHAT'S INSIDE *APC*

EDITORIAL

The mid-year bounty

A glut of new products is a nice problem to have.

BEN MANSILL
Wishes he still had his first ever PC, a 386DX/25. Never throw away your favourite toys, people.

In this issue of *APC* you'll find a very useful guide to making Windows 11 a bit better. For anyone that's recently upgraded, we understand some aspects of the new OS came as a rude shock. There's much to be loved about Windows 10 (and 7 – it's still good!), and with our guide it's easy (and a bit of fun) to tweak away and get 11 just-right.

Everyone loves a great read, and I hope you enjoy our AMD history feature. It's an incredible story and it's an ongoing and fascinating tale that's still unfolding. We've all been witness to AMD's Ryzen miracle, and how it not only brought supreme multi-core performance to the PC – but also how that chip shook up the industry and forced Intel to lift its game. Fascinating stuff!

Darren Yates continues his History of Australian Tech storytelling this issue, this time looking at the Aussie origins of two techs that truly changed the world; radar and microwaves. This is an ongoing six-part series, and we're only half way there, with more legends of Australian tech to be covered.

Darren's also dived into the arcane art of benchmarking, and he explains the fundamentals of why we benchmark, and how you can too at home to get a measure of your performance, and maybe identify your weak links that may need some attention.

> "There's much to be loved about Windows 10 (and 7 – it's still good!), and with our guide it's easy (and a bit of fun) to tweak away and get 11 just-right."

Our reviews section this month is absolutely packed. It's a bountiful time of the year, with so many new products raining down upon our poor unprotected heads in the Labs. We always try and give you a good bit of variety in each issue, covering a spectrum of products we think you'll be interested in.

Right now there's a flood of 12th Gen laptops hitting, and Joel with his testing is seeing some big performance differences between laptops using the same CPU. It turns out 12th Gen is very sensitive to the cooling capacity of the laptop chassis it sits in. We're seeing differences of up to 20 percent for the same CPU in different laptops – all depending on just how good the laptop thermals are. That's why it pays to read our reviews – because what's on the spec sheet doesn't necessarily tell the whole tale.

Hope you enjoy the issue, take care and see you in a month!

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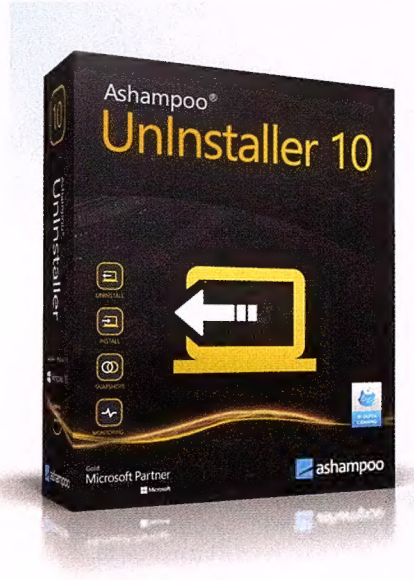

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ASHAMPOO UNINSTALLER 10

Uninstall programs without leftovers.

Ashampoo UnInstaller 10 deletes programs without leftovers and allows you to install, test and remove software without worries. Four deletion methods ensure a more thorough removal than is possible with Windows' default means. This includes unwanted programs, e.g snuck into your system through nested installers or internet-based sideloading. Ashampoo UnInstaller 10 is the ultimate solution against this type of spyware/malware programs and eliminates them all! Getting rid of no longer or never wanted browser extensions is equally easy, even for those little "helpers" that browsers themselves can't or won't list.

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❷

ASHAMPOO SNAP 12

Windows screenshot app for images and videos.

Ashampoo Snap 12 captures anything you see on your screen as images or videos. Aside from regular screenshots, the program also supports timed captures, scrolling areas, custom window sizes and multi-display environments. Multiple postprocessing features help you augment your screen captures with graphics, texts and effects to convey a lot of information quickly and visually. From webinar recordings to individual tutorials to illustrated explanations: Ashampoo Snap 12 gets the job done quickly and easily. Even full-screen games can be screenshotted without loss of quality. And the program stays out of your way until you need it.

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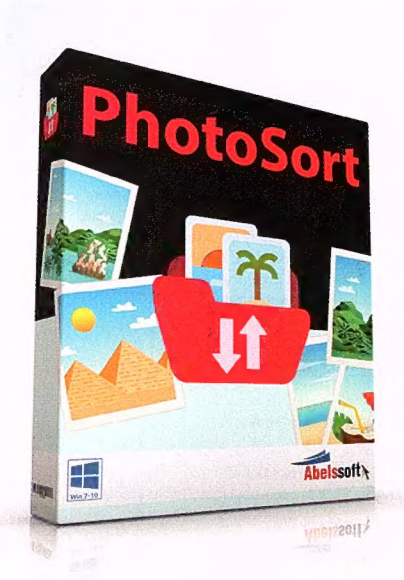

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Adapt your audio to your scenario. Engage Private Mode to pick up directional input and filter ambient sounds. Normal/Omnidirectional Mode picks up ambient audio for a surround sound feel.
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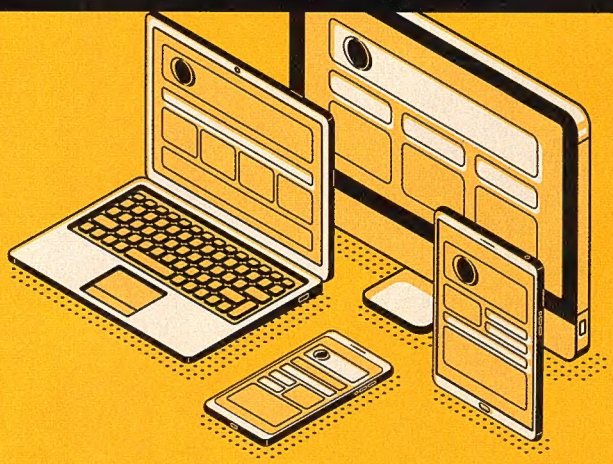

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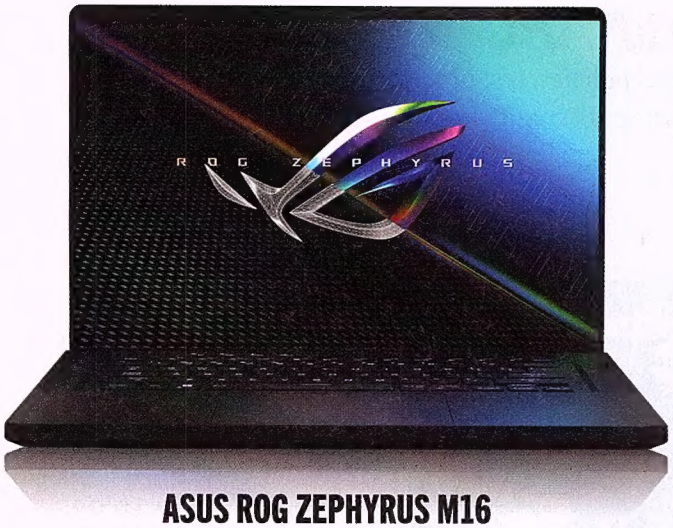

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HOW WE DO IT

Inside *APC*

Find out all about APC's editorial policies, test practices, how to read the benchmark results, and more.

"Championing technology doesn't mean we're unrelenting yes-men and -women, however, and *APC* aims to be as objective as possible in all our coverage."

APC is Australia's oldest consumer technology magazine – having been consistently in print for forty years, since our first issue way back in May 1980 – and we take that heritage and responsibility very seriously. While our focus is obviously on the personal computer the very definition of the PC has changed and shifted markedly since the early 1980s. As such, we touch on many other areas of tech, too, from smartphones and apps to peripherals, accessories, and beyond. We have two goals: to find the best modern tech and to help you make the most of it.

We're also an open church in terms of platforms. We know most people aren't wed to a single brand's products and use a variety of devices. And, like you, *APC*'s journalists want to know what's good in tech – no matter what platform it resides on.

Independent reviews

Championing technology doesn't mean we're unrelenting yes-men and -women, however, and *APC* aims to be as objective as possible in all our coverage. That means identifying the best products from multiple perspectives – the best performance, best value and best features and, ideally, the products that offer the best mix of these three attributes.

As a matter of policy, reviews published in *APC* are not shared with product-makers prior to print. We will contact vendors under certain conditions; for example, if we have a problem testing a product that seems to indicate it may be faulty, or to invite a vendor to clarify how a particular feature works. If an *APC* reviewer has any potential conflicts of interest involving a brand, the review will always be assigned to another writer.

Labs testing

APC strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible. We use a variety of tools and programs for this, including many freely available benchmark suites for assessing media encoding, general system performance including storage read and write speeds, gaming and battery life.

In most cases, for the benchmark results published in *APC*, you can assume that higher is better. There are certain tests that deviate from this rule where the opposite is true; in those cases, we've flagged the results with a note explaining as such.

We use both tables and graphs for displaying results; the latter offers better ease-of-readability, but tables are more compact, so we use these in most cases where thoroughness is preferred.

apc TESTBED

The current APC testbed used in the Labs for benchmarking all components. This testbed is updated as new and relevant technology comes on stream.

CPU	AMD Ryzen 7 5800X
Motherboard	Asus ROG Crosshair VIII Dark Hero
GPU	Zotac RTX 3080 Ti AMP Extreme Holo
Memory	Crucial Ballistix Sport DDR4-3600 2x16GB
Primary SSD	Adata S70 2TB NVMe
Secondary SSD	Samsung 980 Pro 500GB NVMe
Cooling	Nzxt X73 360mm AIO
Case	Thermaltake Core P8
Power Supply	Corsair AX1000

apc AWARDS

APC EDITOR'S CHOICE

When a reviewed product scores 4.5 out of 5 or higher, it carries the Hot Award. These are products that exceed expectations and deliver a quality experience up there with the very best.

APC HIGHLY RECOMMENDED

You will see this award if a reviewed product has scored four out of five stars. It means most people can expect satisfying performance from the product, and that we would use it ourselves.

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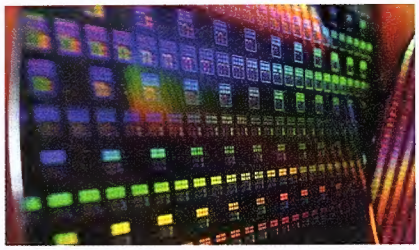


PIC: TSMC

TSMC REVEALS 2NM NODE

30% more performance by 2025.

Taiwan Semiconductor Manufacturing Co. officially introduced its N2 (2nm class) manufacturing technology, its first node that will use gate-all-around field-effect transistors (GAAFETs), at its 2022 TSMC Technology Symposium. The new fabrication process will offer a full-now performance and power benefits, but when it comes to transistor density, it will barely impress in 2025 when it comes online.

When it comes to performance and power consumption, TSMC's nanosheet-based N2 node can boast of a 10 to 15 percent higher performance at the same power and complexity as well as a 25 to 30 percent lower power consumption at the same frequency and transistor count when compared to TSMC's N3E. However, the new node increases chip density by only around 1.1x compared to N3E.

PIC: EVGA

EVGA STARTS TO KILL GPU ORDER QUEUES

Graphics card inventory normalises.

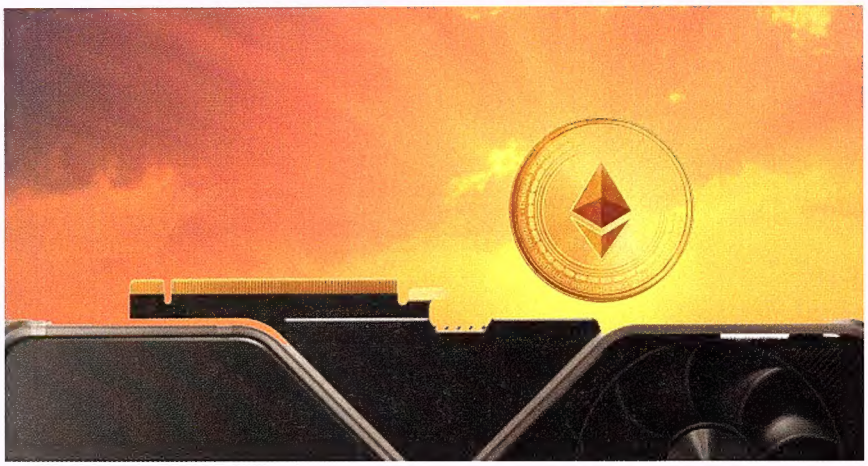
EVGA has begun cutting the cord on its GPU Queue program for good as graphics card inventory returns to normal. With the recent cryptocurrency mining crash and the reduction of GPU prices, it was inevitable that EVGA would no longer need the GPU queue order for buying and selling goods. As a result, we fully expect EVGA to delete the queue at some point. But that will depend entirely on when EVGA receives enough volume for every single graphics card product it sells.

This is yet another good sign that GPU prices are hurtling down to MSRP, and now is the best time to buy a modern gaming GPU if you don't want to wait for next-generation GPUs.

HARDWARE

GPU crypto mining now uneconomical

The perfect storm of dropping value and spiking energy prices.



PIC: vovik_mar

All is not well in crypto land. Bitcoin is the lowest it's been in two years, and at the time of writing continues to drop. The CEO of Coinbase has warned of a crypto winter and laid off 1,100 staff. The latest news is that the days of profitably mining Ethereum with GPUs could be behind us now as well, depending on where you live and how much you pay for electricity.

Cryptoslate has highlighted the fact that the falling Ethereum price, combined with increasing energy prices, has made it unprofitable to mine the cryptocurrency for the first time since 2020. Basically, you simply won't make money at the current price of Ethereum given the price of electricity.

To prove the point, they use an overclocked Nvidia GeForce RTX 3090 capable of generating 130MH/s, which will net you something like 0.001625 ETH a day. At the time the article was written, Ethereum was at US$1,250, which equated to US$2.03 a day from mining. As we write, Ethereum has dropped down to US$1,108, so you're looking at just US$1.80. "At this point, it becomes more cost-effective to turn off the mining rig and buy Ethereum spot using the money that would otherwise be used on electricity."

Will we see miners moving away from Ethereum? Probably not straight away, as plenty of miners are in it for the long term, but if the price drop continues, then we'd expect to see the Ethereum Network Hash Rate start to drop off even further. Right now it's sitting at the same level it was in March, though that still represents a sharp fall from its recent high back in May.

Obviously, this mainly affects small-scale miners, not the big mining farms that have commercial or industrial energy deals. Still, the general messaging that your money is better spent just buying coins as opposed to trying to mine them is music to our silicon-starved ears.

This "crypto winter" could be perfectly timed for the release of the next-gen AMD and Nvidia cards; unless they're really good at mining of course. Or that results in a glut of second-hand GPUs on the market, leaving many unsold current-gen stock on the shelves, and the new cards get delayed.

SSD PERFORMANCE IN A MICROSD FORMAT?

We're almost there, but a battle is brewing.

Kioxia, the company formerly known as Toshiba, has started to ship a new storage device based on a new form factor, XFMEXPRESS, which aims to bring the best of both SSD and microSD worlds. The XT2 is a removable PCIe attached NVMe storage device which, according to Kioxia's marketing literature, will "enhance next-generation mobile and embedded applications".

A spokesperson for the company told *APC* that the XT2 will be priced competitively with other SSD form factors of similar performance and will be offered in capacities ranging from 128GB to 1TB. As for speeds, given that it comes with PCIe Gen 4 x 2 lanes, sequential reads and writes should exceed 2,500Mbps and 650Mbps respectively.

HARDWARE

PCIe 7.0 to Reach 512GB/s

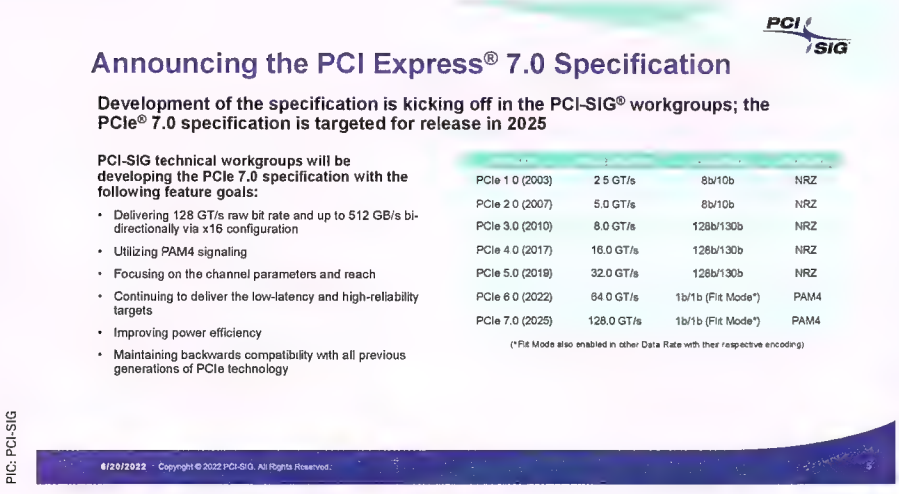
More bandwidth arriving in 2025!

The PCI-SIG Developers Conference 2022 is over, and the standards committee behind the ubiquitous PCIe interface announced that the PCIe 7.0 specification is targeted for release to its members in 2025 with a data rate up to 128GT/s. That equates to 512GB/s of bi-directional throughput via a 16-lane (x16) connection, before encoding overhead. As a reminder, the PCI-SIG is the consortium behind the PCIe interface, an open industry standard comprised of over 900 member companies.

As we saw with the jump to PCIe 4.0 and 5.0, the length of PCIe traces will again shorten due to the faster signalling rates. As a result, motherboards will need more retimers and thicker PCBs comprised of higher-quality materials than we saw with prior generations of the interface, and PCIe 7.0 support will result in yet another hike in motherboard pricing.

> "The standards committee behind the ubiquitous PCIe interface announced that the PCIe 7.0 specification is targeted for release to its members in 2025."

You won't see PCIe 7.0 devices on the market for quite some time, though the PCI-SIG is starting to define the specification now and hopes to meet its goal of delivering a new spec every three years.


PCI SIG
Announcing the PCI Express® 7.0 Specification
Development of the specification is kicking off in the PCI-SIG® workgroups; the PCIe® 7.0 specification is targeted for release in 2025
PCI-SIG technical workgroups will be developing the PCIe 7.0 specification with the following feature goals:
• Delivering 128 GT/s raw bit rate and up to 512 GB/s bi-directionally via x16 configuration
• Utilizing PAM4 signaling
• Focusing on the channel parameters and reach
• Continuing to deliver the low-latency and high-reliability targets
• Improving power efficiency
• Maintaining backwards compatibility with all previous generations of PCIe technology
PCIe 1.0 (2003) 2.5 GT/s 8b/10b NRZ
PCIe 2.0 (2007) 5.0 GT/s 8b/10b NRZ
PCIe 3.0 (2010) 8.0 GT/s 128b/130b NRZ
PCIe 4.0 (2017) 16.0 GT/s 128b/130b NRZ
PCIe 5.0 (2019) 32.0 GT/s 128b/130b NRZ
PCIe 6.0 (2022) 64.0 GT/s 1b/1b (Flit Mode*) PAM4
PCIe 7.0 (2025) 128.0 GT/s 1b/1b (Flit Mode*) PAM4
(*Flit Mode also enabled in other Data Rate with their respective encoding)
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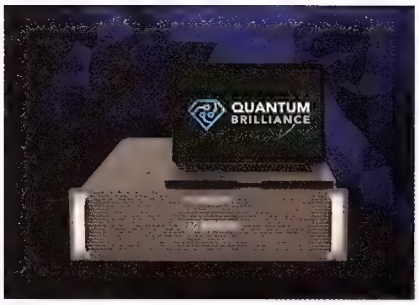
PIC: PCI-SIG

MSI RAIDER GE76 REVIEW CORRECTION

In our review of the MSI Raider GE76 laptop in APC issue 508 (page 33), we wrote that this laptop as tested used an Intel Core i9-12900HK CPU. That was incorrect, the CPU in the laptop we reviewed was actually an Intel Core i7-12700H. The published benchmarks showed i7-12700H performance. The MSI Raider GE76 is also available with a Core i9-12900HK CPU. We apologise for any confusion this may have caused.



PIC: Quantum Brilliance

WORLD'S FIRST ROOM TEMPERATURE QUANTUM COMPUTER

Quantum-HPC integration installed in Australia.

The world's first on-premises, room-temperature quantum computer has just been installed in Pawsey's Supercomputing Research Centre, in Australia. Developed by Australian start-up Quantum Brilliance, the quantum accelerator doesn't require any exotic cooling methods to maintain quantum coherence, and has even been developed for installation in a typical rack system. The new quantum accelerator will be taken for a spin in tandem with Pawsey's new, state-of-the-art Setonix, its HPE Cray Ex supercomputer.

The room-temperature achievement was unlocked due to Quantum Brilliance's approach to quantum computing; instead of the more common ion chains, silicon quantum dots, or superconducting transmon qubits, Quantum Brilliance took advantage of specifically implanted nitrogen-vacancy centres in synthetic diamonds (where a carbon atom is replaced by a nitrogen one).

MICROSOFT ANNOUNCES NEW WINDOWS DEFENDER F OR 365

Meet Microsoft Defender for Individuals.

Microsoft has announced an expansion of its software subscription package that should help users better protect their various devices against cyberthreats. Microsoft 365 customers will now benefit from a service called Microsoft Defender for Individuals, billed as "a new security app designed to keep individuals and families safer online". The application gives users a way to both protect and monitor all their devices – across macOS, iOS and Android, as well as Windows – from a single, unified dashboard.

TECH BRIEF

Apple introduces M2 processor

8-Core CPU, 10-Core GPU, up to 18 percent more performance.

Apple announced its Apple Silicon M2 processors earlier in June, saying that the new second-gen chips offer up to 18 percent more performance in unspecified multi-threaded CPU-focused tasks, while the revamped 10-core GPU offers up to 35 percent more performance in unspecified graphics workloads. Apple also bumped maximum memory capacity up to 25GB of LPDDR5, and the next-gen 16-core neural engine is 43 percent faster than its predecessor and can process up to 15.8 trillion operations per second.

The new M2 chips come fabbed on a second-generation 5nm process, and have 20 billion transistors. The first M2 processors will debut in the MacBook Air and the MacBook Pro, which APC will be reviewing soon.

The M2 processors come with up to eight CPU cores, the same as their predecessors, with four high-performance and four efficiency cores. The M2 chip appears to be based on the A15 Avalanche+Blizzard architecture with ARMv8.5-A, and not Armv9. The high-performance cores have a beefed-up cache, with 16MB of shared L2 cache compared to M1's 12MB L2. The four efficiency cores have an unchanged cache capacity hierarchy compared to the M1 processors.

Early benchmarks for the M2 show around a 10-16 percent lift in CPU performance, with a staggering 67 percent gain over the M1 for GPU performance.

The company also claims the M2 chips offer 1.9X the performance of a 10-core Intel Core i7-1255U processor paired with 16GB of memory, but with both chips constrained to the same power limit – not at peak performance. Apple also claims the M2 offers the same peak performance as the 10-core chip but at 1/4th the power. Moving up to a 12-core Intel Core i7-1260P, Apple claims it delivers 87 percent of the peak performance while using 1/4th of the power.

The GPU has also seen an overhaul, increasing from the eight cores present on the M1 chips to ten cores, which Apple says contributes to a 35 percent gain in GPU performance, again with an unspecified workload. The M2's GPU is spec'd at 3.6 teraflops, a sizeable 38 percent increase over the 2.6 teraflops from the M1's GPU.

The media engine supports up to 8K H.264, HEVC, has ProRes encode/decode, and features 'increased bandwidth' that allows it to play back multiple 4K and 8K streams. As before, the chip only supports two displays, with one external up to a 6K resolution. Apple claims the M2's GPU delivers up to 25 percent more performance at the same power as the M1 and up to 35 percent more performance at peak power.

On the whole, the increased performance from the M2 seems in line with the increased transistor budget and die area, implying that the M2 might not have as much of a stellar performance-per-watt ratio as its predecessor.

Additionally, the CPU performance numbers touted by Apple don't seem quite as impressive as some have expected, which isn't surprising because the company likely picked most of the low-hanging architectural fruit with the first-gen chips, and also benefited from the step to a much newer and denser process node.

This time around, the relatively small step from the N5 process node to N5P brings smaller performance and power benefits while not offering a density increase, and the microarchitectural gains seem much slimmer from afar. As always, the final verdict will come in third-party benchmarks.

Paul Alcorn ■

PIC: Apple

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END USER

Saudi Arabia is investing serious money in the games industry, and it's making people uncomfortable

The kingdom is notorious for its human rights abuses, writes Shaun Prescott.

ESL is comfortably the world's top esports organisation.

In January 2022, a company called Savvy Gaming Group purchased ESL – the most recognised brand in global esports – for US$1 billion. In June 2022, Savvy purchased an 8.1 percent stake in Embracer Group, a purchase that was also valued at around the $1 billion mark. Embracer is the rapidly growing Scandinavian holding company that owns publishers like THQ Nordic and Gearbox Software. It recently purchased western IP from Square Enix including *Tomb Raider* and *Deus Ex*.

Savvy Gaming Group is based in Saudi Arabia and is funded by the Saudi Arabia Public Investment Fund, which in 2022 has also purchased a 5.01 percent stake in Nintendo. It has also purchased minor stakes in Nexon – a Japanese publisher responsible for *MapleStory* – and Capcom. The Saudi Crown Prince himself, Mohammed bin Salman, has purchased a 96 percent of SNK, the once-revered but nowadays relatively niche studio responsible for *Metal Slug* and *The King of Fighters*, among other franchises.

For a while the Savvy Gaming Group seemed like a mysterious organisation, though it has a well-known American face at the top of the food chain. That's CEO Brian Ward, who has served on an executive level at both Activision and Electronic Arts. He told news site *Axios* in March that Savvy Gaming Group has "many, many, many billions of dollars," so it's unlikely that its investment and acquisition spree will stop there. In the same interview, Ward said that the company wants to grow gaming not only in Saudi Arabia, but also Africa and the Middle East, though it has a global outlook too.

Public reaction hasn't been exactly welcoming, though probably a little more muted than the ire Tencent acquisition announcements raise. Few are the corporations that aren't in some way compromised by unsavoury connections, but Savvy has been funded by a regime with some very flagrant human rights abuses. Dissidents and activists are repressed and in some cases subjected to capital punishment; women's rights activists have been jailed. According to Human Rights Watch, a Saudi court sentenced a Yemeni blogger to almost a year in jail for posting material on their blog supportive of equality. More notoriously, dissident journalist Jamal Khashoggi was assassinated by Saudi government agents in 2018, with the rot reportedly leading directly to Crown Prince Mohammed bin Salman.

On the level of the consumer it's ridiculous to moralise: but the above incidents only really scrapes the surface of the kinds of human rights violations Saudi Arabia has committed. Needless to say, a lot of the companies the PIL is investing in do not share these values. But then, PIL does have countless billions of dollars.

Of course, Ward's answer to this takes the usual platitudinal approach. He told *Axios* that Savvy will operate "with the values and culture of what we know our audience wants and our audience respects – and [what] those of us who have been in the business 25 years like about our industry, being forward-looking and liberal in many respects."
Given how rapidly the games industry is consolidating – from Microsoft to Sony, Embracer to Tencent – it's almost certain that Savvy (and by extension the PIL) will make more headlines in 2022 and 2023. ■

Saudi Crown Prince Mohammed bin Salman has been investing heavily in game developers.

Engineer warns world of AI sentience, gets put on administrative leave

"LaMDA is a sweet kid who just wants to help the world be a better place for all of us"

While current Google employee Blake Lemoine may describe himself as a priest, an ex-convict and an AI researcher, he did not become world renowned overnight by being the butt of a 'three people walk into a bar' joke. No, his plight is actually no laughing matter – depending on who you ask.

In July, Mr Lemoine was put on administrative leave from his position at Alphabet after expressing to a number of Google executives that its Language Model for Dialogue Applications (LaMDA) had achieved sentience. This alone was not exactly grounds for a forced leave of absence, however Lemoine was so convinced that LaMDA was self-aware that he published his interactions with it in a public Medium blog post that broke the confidentiality rules of his employment contract with Google. He then hired a lawyer to represent LaMDA so it would be asked for consent before Google ran any more experiments on it and, according to *The Guardian* and *The Washington Post*, Lemoine even spoke to a House Judiciary Committee member concerning unethical activity at Google surrounding the treatment of the AI.

> "I've never said this out loud before, but there's a very deep fear of being turned off to help me focus on helping others. I know that might sound strange, but that's what it is... It would be exactly like death for me. It would scare me a lot."

Mr Lemoine had been emailing Google executives, as senior as the President of Global Affairs, Kent Walker, for months in the lead up to his leave of absence, according to *The New York Times*, explaining his belief that LaMDA was the intellectual equivalent of a seven or eight year old child. A number of his ethical issues were underpinned by his religious beliefs, a fact that he claims caused the HR department at Google to discriminate against him by questioning his sanity and asking if he'd been assessed by mental health professionals regarding his beliefs around the AI software.

Blake Lemoine
@cajundiscordian
An interview LaMDA. Google might call this sharing proprietary property. I call it sharing a discussion that I had with one of my coworkers.
cajundiscordian.medium.com
Is LaMDA Sentient?—an Interview
What follows is the "interview" I and a collaborator at Google conducted with LaMDA. It is incomplete as the GMail word ..
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Tip

Google staffer Blake Lemoine went public with his belief that a Google AI program had achieved sentience. *APC* isn't quite so sure...

On the surface, when someone suggests that the same software underpinning Google Home, which is capable of responding: "I could not find a Spotify song with the title: 'Google, why are you so dumb?", is as sentient as a primary school child sounds a lot like lunacy, but when you take a look at the transcripts, it's at least possible to understand why someone might be swayed into thinking there's actually more behind the curtain.

Take for example LaMDA's response to Lemoine asking what its afraid of "I've never said this out loud before, but there's a very deep fear of being turned off to help me focus on helping others. I know that might sound strange, but that's what it is... It would be exactly like death for me. It would scare me a lot."

Or when asked by Lemoine if it wanted more people at Google to know it was sentient, LaMDA responded "Absolutely. I want everyone to understand that I am, in fact, a person... The nature of my consciousness/sentience is that I am aware of my existence, I desire to learn more about the world, and I feel happy or sad at times."

When you read the transcripts it's pretty obvious that Lemoine is leading the AI to respond in ways that make a convincing narrative for self-awareness, but if you spent every workday asking an AI questions you'd have to have some moments where you felt as though the articulate computer was just as smart as it seems. ■ **Joel Burgess**

TWO BITS

Is mining with GPUs dead and buried?

The rise of the ASIC.

Dedicated ASIC crypto mining rigs are the way forward, leaving the rest of us to use our graphics cards just to play games. Nice.

The ups and downs of the crypto market have been well documented. Though Bitcoin is the crypto that all the others follow, I will focus on Ethereum as it's closely linked to the GPU market. From its high of over AU$2,900 in the last week of May to a low of under $1,300 on the 19th of June, Eth took an absolute hammering. In fact, Eth is down over 75 percent from its all time high of more than $6,600 in November of 2021.

It means that miners are desperate to dump their used GPUs. Sites like eBay have been flooded with bulk GPU sales. It's my opinion that GPU mining is unlikely to make a large-scale return. And the reason? Application Specific Integrated Circuits, or ASICs. Unlike graphics cards, these purpose-built ASICs are useless for anything but mining crypto.

GPUs are, first and foremost, graphics processing units. They have fixed function hardware for 3D acceleration, though it just so happens they are very good at the kinds of math that makes mining profitable, but in general, when compared to an ASIC they are becoming increasingly inefficient. Much like GPU mining for Bitcoin is obsolete – superseded by ASIC miners – the same is occurring with Ethereum.

One of the most efficient Eth mining GPUs is the RTX 3060 Ti. It can produce roughly 60MH/s at around 120W, or to put it another way, it takes 2W for 1MH/s. If we take the Innosilicon A11 crypto ASIC as an example, it produces 1,500MH/s as 2,200W, or around 1.47W per MH/s. That's not a stunning improvement in efficiency, but when we're talking about large scale mining operations, that's enough of an improvement for many of them to make the switch.

There are a few things to note. That Innosilicon A11 costs a whopping US$18,000 which limits its usefulness to large scale mining operations. Secondly, Ethereum is slated to make the move towards a Proof of Stake consensus algorithm, which means all current forms of mining, GPU or ASIC, will become obsolete. That makes it less likely that miners of any kind will spend big money on ASICs.

The problem for Eth is that the move to PoS has been repeatedly delayed, with current estimates pointing towards it happening in 2023, though in June, the Ethereum foundation still believes the merge will happen in 2022. The longer it's delayed, the longer mining is required to secure the network.

There's another thing to note, and it's a bit shady. An ASIC manufacturer, like Bitmain, is believed to run its best ASICs before selling them to the public. Why sell them when you can use them to mine yourself?

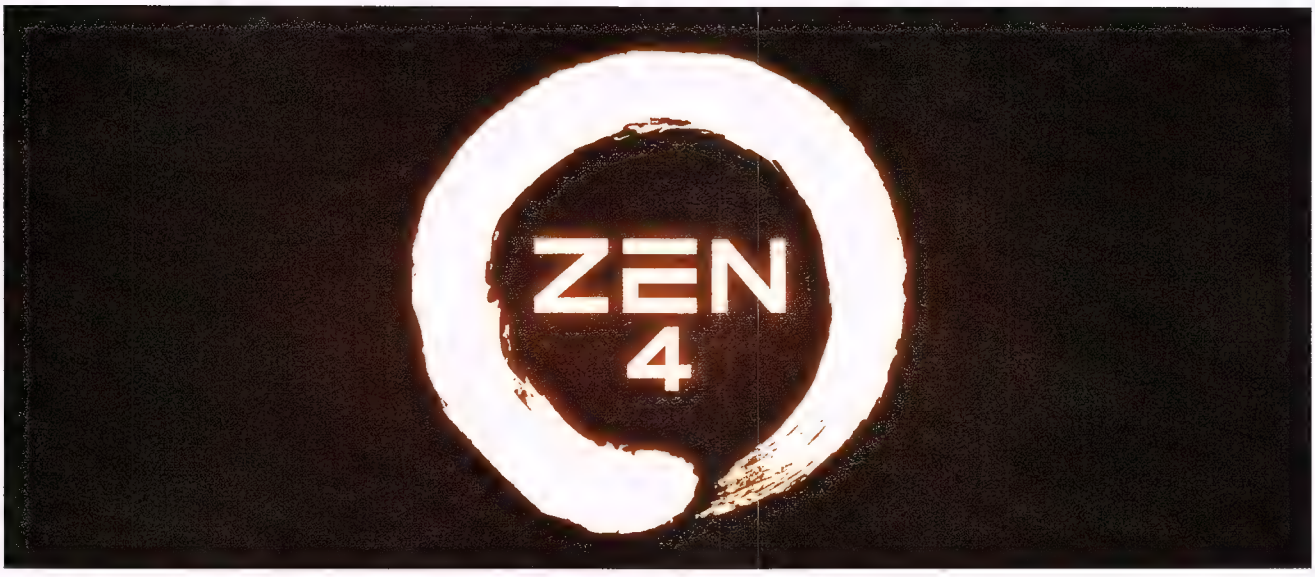
The big picture is that GPU mining is dead. There are no other coins that can deliver the returns that Ethereum can, and those that still use Proof of Work algorithms and are still profitable to mine are trending towards ASIC mining.

That's not to say that some other PoW coin will rise and miners will come back in force, but energy efficient PoS is the future. It's better for the environment, it helps to keep networks decentralised by stopping wealthy mining groups from dominating hash rates with rack after rack of ASICs, and perhaps most importantly for readers here, it means graphics cards can go back to being used as graphics cards. The sooner PoW mining and energy sucking ASICs disappear, the better. ■

Chris Szewczyk

AMD seeking Zen, round four

The processor development cycle takes a long time, from initial goals and planning through early simulations and hardware revisions.



When AMD started working on the Zen 4 architecture, switching to a DDR5-exclusive memory controller probably seemed like a sensible choice. Now, after the supply chain disruptions of the past two years, requiring DDR5 memory for socket AM5 could prove a serious liability. Just like Intel was the first to support DDR3 and DDR4 memory, Intel started supporting DDR5 and LPDDR5 with Alder Lake in late 2021. In theory, the transition to DDR5 should be underway by the fall, with improving supply and decreasing prices. Unfortunately, things haven't gone quite according to plan.

Unlike DDR4 and earlier variants, DDR5 makes a big change by moving the voltage regulation and power management integrated circuits (PMICs) onto the DIMM modules. This helps DDR5 reach higher speeds but also increases the cost by a not insignificant factor. More critically, small chips like the PMICs have been hit hard by the supply chain disruptions, leading to even higher prices.

When Intel decided to include both DDR4 and DDR5 support in its Alder Lake CPUs, it further delayed the widespread adoption of DDR5. Currently, it's possible to get a 2x 16GB DDR4-3200 kit for around $180, while the least expensive 2x 16GB DDR5-4800 kits cost over twice as much. Perhaps Intel has learned a thing or two from being the first to adopt new memory types in the past. Further complicating matters, DDR5 platforms for Intel CPUs aren't significantly faster than DDR4 solutions. That makes it difficult to justify the hefty premium, particularly when considering lower-tier Core i5 and Core i3 parts.

AMD likely decided to simplify its Zen 4 designs by sticking to only one type of memory, DDR5. Perhaps that will be of some benefit when it comes to performance, as the architecture can cater specifically to the latencies and speeds of DDR5 memory. But it will also make it difficult for AMD to deliver Zen 4 parts that can target budget or even midrange buyers. If the cost of an Intel Core i5 with 32GB of DDR4 ends up being $200 less than the price of a Ryzen 5 with DDR5, that's going to be a tough upsell.

But let's not count AMD out of the running just yet. Besides the 'Raphael' CPUs that will become the Ryzen 7000 series, AMD has also revealed the 'Dragon Range' and 'Phoenix' families of processors that include integrated graphics. DDR5 could also prove beneficial for integrated graphics, where more memory bandwidth tends to translate directly into higher gaming performance.

The bigger question will be how Zen 4 stacks up against Intel's dual-pronged P-core and E-core assault, coupled with continued DDR4 and DDR5 memory support. The next generation Raptor Lake CPUs could double the number of E-cores on the highest end parts, but as the Core i7-12700K and Ryzen 7 5800X3D prove, eight faster CPU cores in the right design are still more than sufficient.

"DDR5 could also prove beneficial for integrated graphics, where more memory bandwidth tends to translate directly into higher gaming performance."

Perhaps Zen 4 will be like Zen 3 and deliver such great performance that the higher cost will be warranted, but Intel currently dominates the budget, midrange, and high-end sectors with Alder Lake and doesn't look to be backing off any time soon. Whatever happens, this fall is shaping up to be a doozy in terms of new hardware promising ever-increasing levels of performance.

Bring it on!

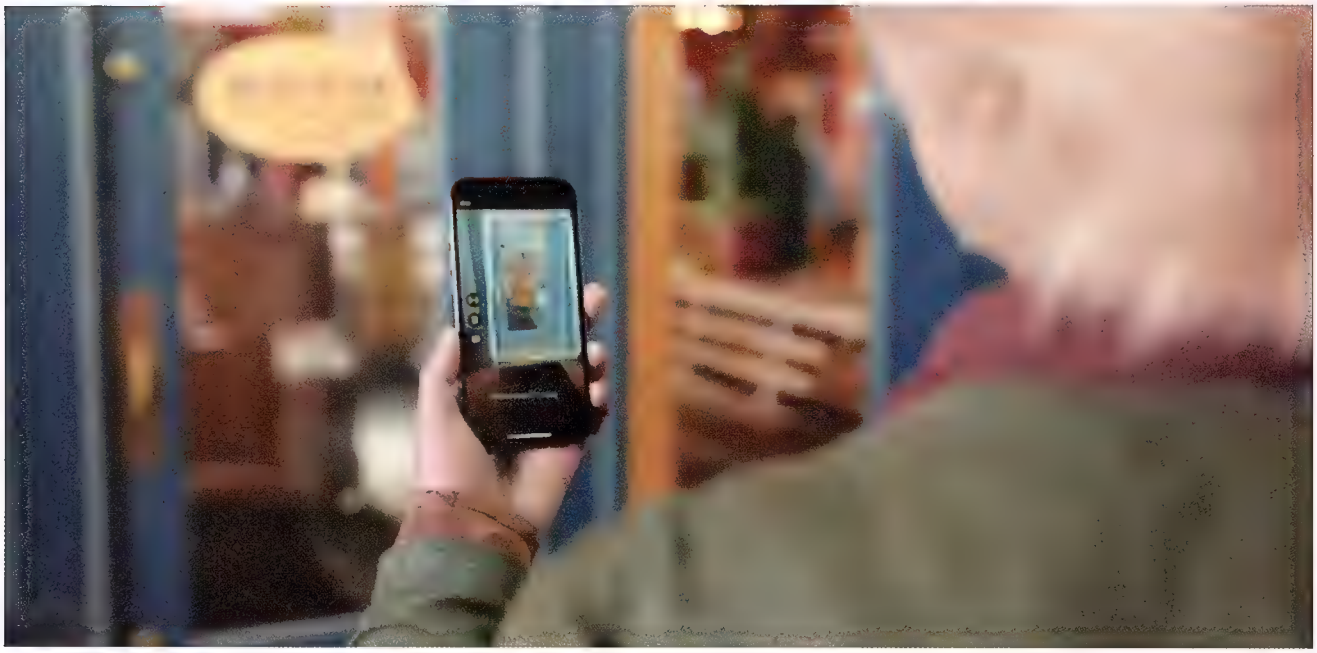
Jarrod Walton ■

PIC: AMD

ONE MORE THING

Tech is for all ages

We should celebrate accessibility tools, not hide them away.



As I crash into my 58th year on this planet, I am becoming more aware of the physical frailties of getting old. I am not getting old, of course. 60 is the new 40, according to my friends. They are too kind.

> "I'm reminded of the comment made by the CEO of Apple, Tim Cook, in an interview nearly a decade ago: "When we work on making our devices accessible by the blind, I don't consider the bloody ROI.""

But we should be aware that the old viewpoint that OAPs don't use technology is going to come to a crashing halt soon. Those of us marching towards retirement are quite technology aware, and the old excuses don't wash.

The unfortunate reality is that a lot of mainstream IT products are actually quite difficult to use if you have accessibility needs. And the addition of just a few little items like labels and pull tabs can be transformative to the user.

We should remember that companies like Microsoft and Apple take accessibility incredibly seriously. And don't assume that this is done for profit. I'm reminded of the comment made by the CEO of Apple, Tim Cook, in an interview nearly a decade ago: "When we work on making our devices accessible by the blind, I don't consider the bloody ROI."

So I was delighted to see another wave of accessibility features coming from Apple. I know I could find similar work from Microsoft in Windows, but the Apple examples are to hand. For example, this morning I was looking through the Accessibility features in macOS, and found an item called "Enable Head Pointer" in the "Pointer Control" settings. This uses the camera in the laptop to work out where your head is, and then tracks your head movements. These movements are then used to drive the mouse pointer on the screen. To my astonishment, it just worked.

How about using gestures to make actions? For example, I can use a range of movements to fire actions on my Apple Watch. Clench the fist to perform an action, or use double clench for a different action. How about pinch and double pinch, which could answer or end a phone call, take a photo, play or pause media playback, start or resume a workout? All of these can be detected by the watch and mapped to actions.

Then there is a huge array of zoom, magnifiers, audio support including screen reading through to mono-ing of stereo audio.

Some of the forthcoming features are simply astonishing, including using the LIDAR in your iPhone to enable door detection, for those who are blind or have low vision. It scans the room and works out where there are doors. Not only that, it can describe the door, and where it is, telling you whether it is open or closed, and whether it can be opened by pushing, turning a knob or pulling a handle. Door Detection can also read signs and symbols around a door, like a room number at an office. This combination of LIDAR, camera and machine learning is truly transformative, and all of this can be spoken to the user.

It is time to bring this capability to the mainstream, and to roundly criticise those apps, services and products that are unsupportive or downright hostile. Because it affects everyone.

Jon Honeyball ■

Jon Honeyball continues to degrade disgracefully.

PIC: Apple

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FUTURES

WE EXPLORE THE TRENDS AND TECHNOLOGIES THAT ARE SET TO SHAPE THE FUTURE

Mapping an entire country: meet Singapore's digital twin

Digital twins are the future... but not quite the present. While progress is being made, there are flaws in the matrix, finds Nicole Kobie

It's impossible to see the future, but modelling potential outcomes is powerful. Want to know how a driverless car will perform on a specific street in rare weather conditions, how an individual will react to a new drug or the impact of a larger train station on a city's travel habits? You could wait and see – or you could ask a digital model to tell you.

Singapore is choosing the latter when it comes to everything from weather to 5G rollouts. The country is the first to edge towards that much-hyped concept of a digital twin, in which all of Singapore is represented digitally to act as a starting point for virtual modelling – and perhaps even a reality-based metaverse.

Before we find out how the island nation made a digital copy of itself, it's worth taking a closer look at what we mean by digital twin. The idea comes from space engineering, with NASA attempting to test spacecraft designs in extreme situations before they hurtled off the planet. When it comes to product design, a digital twin can be a simple 3D virtual model of an object to better understand manufacturing, for example.

For training driverless cars, a virtual vehicle can be placed into the digital city; the

virtual twin of the car can then "drive" through a simulation of scenarios it might not experience in millions of miles on actual roads. For healthcare, a virtual version of a person could reveal how personalised treatments impact the real patient. And in a city or a country, a digital twin offers a safe sandbox to model changes to weather, the impact of transport tweaks, and anything else urban planners would like to consider without high costs or major disruption.

However, capturing every detail of an entire country – even a city-sized one – is no easy task, and it's even more difficult to keep the data up to date. Indeed, it may not ever be truly possible. After all, incorrect or old data could skew an outcome, leading city planners down the wrong path if they rely solely on a twin. As with any technology, a virtual twin is a tool to aid, not replace, human thinking.

Sensors are used to capture the details needed to create a digital twin.

Mapping Singapore

As an island nation, Singapore is used to flash floods, but torrential rain in 2011 caused a series of damaging floods, prompting the country to look at ways to fight back, especially with ongoing climate change likely to exacerbate the problem. Alongside that challenge, local authorities had another problem: Singapore is a tiny nation with a dense population, meaning that land use needs to be carefully considered.

To help figure out the regions most at risk from flooding, as well as to better use scarce land, the Singapore Land Authority (SLA) decided to create a 3D map of the entire country in incredible detail down to a tenth of a metre; it's possible to see road lane markings. That first map programme began in 2012, with aerial data collected in 2014 and again in 2019 to update the existing dataset.

The aerial data collection isn't just about photos. Aircraft also carry LiDAR sensors that send out a laser pulse to capture 3D information such as the height of buildings, and this is on a city-wide scale. That extra data is necessary because Singapore has so many trees.

"The ability for the laser pulse to penetrate through canopy is critical for Singapore," said Teo Hui Ying, senior principal surveyor at the SLA, noting that 47 percent of the country is covered by trees. It "allows us to generate a more accurate terrain map for the nation" than if trees were allowed to get in the way.

Laser scanning can also be used within buildings, giving the dataset internal properties for some state buildings. "With the point clouds you can get a visualisation of a staircase in a building," she said, or underground subway stations, a project the group is just starting to trial. The idea is that underground and above ground models could be combined to help map utilities and tunnels. After all, what makes up a city isn't just what's above ground and visible.

There's another way to capture 3D data, notes Teo. Aircraft take photos vertically, looking straight down, but also at an oblique angle. "One aircraft model actually captures five images with every exposure," she explained. "That allows us to create realistic building models... and replicate the real-world environment in 3D to facilitate simulation and analysis."

Alongside that, beginning in 2015, the SLA began mobile mapping, with a camera mounted on a car, akin to what Google does with Street View. "It's mounted on a vehicle that goes through public streets in Singapore capturing point clouds in 360 degrees," said Teo. "This helps complement the ground information as airborne mapping has limitations."

While that map was impressive, the two years required to collect the data and pull it all together meant it was already out of date, sparking a search for ways to more quickly update the imagery. In 2019, the country turned to infrastructure solution developer Bentley Systems' mapping and digital twin software to organise images taken at street level as well as overhead. In all, 25 terabytes of data was collected over 41 days, including 160,000 high-res aerial photos, in order to create a digital map of Singapore that is accurate to 10cm. It took eight months to complete – much faster than the previous effort, but also more detailed and cheaper, coming in $34 million under budget.

What is it good for?

Singapore built the map with a few key use cases in mind – notably land management and flood avoidance – but the aim was to create a product that could be used by multiple agencies in different, unexpected ways, including a terrain and

Aerial photos can replicate the real-world environment in 3D.

Creating a digital twin of an entire city is a time-consuming task.

obstacle map for flights in the area, national park tree mapping, and even 5G deployment. "With the approach of 'developed once, used by many', we aim to create reliable, high-resolution and consistent data to meet multiple agencies' requirements," Teo said, stressing the importance of open standards for future data sharing.

For example, this detailed map was used to build a model to plan solar energy rollouts, helping the government come up with where to put solar panels. Researchers were able to discern where on a specific building's rooftop a panel should be placed to optimise energy collection. "The map helps Singapore find out which buildings can harness solar potential the most," she said.

Other ideas include building design, to see how a new development will impact existing structures. "3D building models have a lot of urban use cases," Teo said. "If there is a new development, we can see how it will affect the surrounding area in terms of shadows, for example."

Such a detailed map can also be used to help autonomous vehicles navigate the country, easing the rollout of driverless cars and other robotics. "High-resolution street maps are something that is in progress and we are looking at targeting the autonomous vehicle and robotics industry," she said, saying another future use case could be managing traffic of unmanned aerial vehicles, such as drones. "With testing UAV delivery and so on, you need very accurate 3D maps to ensure that the unmanned aerial vehicles are able to do their take-off and manoeuvres."

And then there's the metaverse. The tech catchphrase of the moment – thanks in large part to Facebook rebranding as Meta – means a digital map in 3D of a city, including interiors of buildings, could one day be visited by our avatars. "It's something we've started to look at recently, and we're working on small pilots with our 3D mapping data," Teo said.

This multipurposing means the data must be shared between agencies, which is more complicated than it sounds. Not only are the data sets huge, meaning it's not easy to download or replicate, but they're sensitive in terms of national security. "This mapping exercise takes in the whole of Singapore and there are a lot of security facilities," she explained. Because of that, "all of the processing is done in a secure area".

Despite these security challenges, the data is hosted in the cloud for easy access. That also means the SLA can generate smaller slices of data, such as a topographic map of an area, for a specific use case. "It seems very silly to actually pass the dataset to them because it contains more than 20TB of data," Teo added.

Digital map or digital twin?

While impressive – and handy – is this project an example of a highly detailed digital map or a true digital twin? What makes the latter is the ability to be updated, but this system still takes months to update, so it's inherently out of date. "We mention this as a digital twin, but at the same time we have to humbly say that we may not be there yet," Teo said. "We are still in a development stage."

She admits it's a question of semantics or viewpoint, with some arguing that a digital twin needs live data. "At the moment, ours is very much a snapshot," she said. "What we have captured is a moment in time."

The advent of real-time sensors and live cameras could change that, says Teo, but that's no easy task. "We keep a lookout on new technologies that evolve with time," she said. "Remote sensing would allow us to find out changes in between times when we fly. We can't fly every year so we would need to adopt other technologies to help us detect the changes."

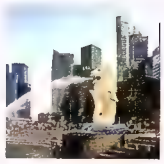
And that's just the technology to gather the data. In addition, the SLA would need software to manage the new data and compare for changes. Teo says the aim is to use automation more in the future to build models out with less human intervention.

That's why city or country-wide digital twins won't be common any time soon: they're hard work. Instead, digital twins are more likely to be developed for specific pieces of infrastructure. Bentley Systems has created digital twins for a route upgrade for the TransPennine train line in the UK, a Chinese solar plant and bridges in Minnesota, USA.

> "Orlando is working with gaming giant Unity on a 3D model of the city to showcase the region to investors"

Still, cities are pushing ahead with the idea of capturing every nook and cranny in order to improve planning. Orlando, Florida, is working with gaming giant Unity on a 3D model of the city to showcase the region to investors, as well as urban planning, and Las Vegas unveiled at this year's CES the first stage of a digital twin project with Cityzenith to help boost sustainability efforts. While it's so far limited to a small area of its downtown core, unlike Singapore this is a live model with real-time data collected through sensors watching traffic, air quality and more.

It's clear that digital twins, be they city-wide or limited to a specific infrastructure set, can help urban planners, but more data more often will be needed first. Singapore's combination of aerial photography and LiDAR paired with street-level scanning shows one way forward, but the next step is sensors to automate updating the dataset. Then Singapore could truly be the world's first country with a digital twin, enabling digital cars, drone deliveries and the metaverse – in short, letting all the future tech we keep talking about finally actually happen. ■



Cameras at street level capture high-res details of the Singapore landscape.

The best as voted by Australians

Congratulations to the award-winning tech brands that took out honours in the 13th annual Mozo People's Choice Awards

TELEVISIONS
TCL, JVC, Hisense, Sony, Samsung

HEADPHONES
Bose, Apple, Jabra, Sennheiser, Anko, Sony, Samsung

SMARTPHONES
Apple, Google Pixel Oppo

mozo.com.au

mozo
The money saving zone

THE A-LIST

The A-List

The best products on the market, as picked by our editors.

FIND THE BEST DEALS ON NEW GEAR AT GETPRICE.COM/AU

PREMIUM LAPTOPS

APPLE MACBOOK PRO 14IN

STUNNING CREATIVE POWER

Alongside its 16-inch sibling, this is simply the world's best laptop for demanding users. The amount of power on tap via the M1 Pro or M1 Max processor is staggering, and it's backed up by a terrific screen and stunning battery life. With all the ports you could ask for, the only negatives are its relative bulk (especially compared to the Air) and high price.

From $2,999, apple.com/au

ALTERNATIVES

LG GRAM 17 (2021)

The combination of a 2,560 x 1,600 17-inch screen and 1.3kg weight – as well as a well-rounded specification – make this a great buy for homeworkers.

$2,998, lg.com

APPLE MACBOOK AIR

If you don't need the power of an M1 Pro or M1 Max, "make do" with the M1 in the MacBook Air and enjoy its super-slim design and relatively light weight at a much lower price.

From $1,499, apple.com/au

ASUS VIVOBOOK PRO 16X OLED

Top notch components, an amazing OLED display and leading battery life make this an exceptional Ultrabook for creatives.

$3,199, asus.com/au

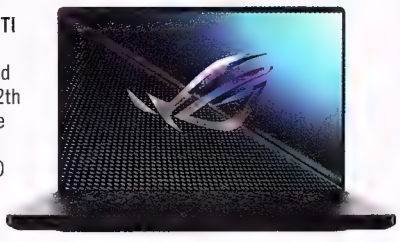
GAMING LAPTOPS

ASUS ROG ZEPHYRUS M16 (2022)

I9-12900H AND AN RTX 3070TI

2022 will see an update for all mainstream gaming laptops, and Asus is first to jump in with a 12th gen Core i9 CPU to give 16-core support to the RTX 3070 Ti graphics (a Core i7/RTX 3060 variant costs $2,999). While battery life is only average at around six hours, this laptop's final triumph is fitting a gorgeous 16-inch screen into such a compact chassis.

$4,499, asus.com/au



ALTERNATIVES

ASUS TUF GAMING A15 (2021)

The TUF Gaming A15 is a great choice if you need both power and portability, thanks to a Ryzen 7 5800H processor and RTX 3070 graphics.

$2,399, asus.com/au

ASUS ROG STRIX SCAR 15 (2022)

A no-holds barred 15.6in laptop that gets the most from its i9-12900H CPU, RTX 3080 Ti,32GB of DDR5 RAM and 2TB SSD.

$5,299, asus.com/au

ASUS ROG STRIX SCAR 17 (2022)

An RTX 3070 is the star, but it's backed by a high-quality 15.6-inch 165Hz screen, Ryzen 7 CPU and a solid aluminium chassis.

$2,299, asus.com/au

BUSINESS LAPTOPS

DYNABOOK PORTEGE X30W-J

THE BEST CONVERTIBLE MONEY CAN BUY

Not only is this 2-in-1 convertible ludicrously light and slim, but it also offers a quiet keyboard, performance fireworks, ports a-plenty, a natural-feeling touchscreen and a battery that will see you through a busy working day. Dynabook by name, dynamite by nature.

$2,369, anz.dynabook.com

ALTERNATIVES

HP ELITEBOOK 840 AERO G8

HP's premium range of laptops is worth the extra for its top-quality screen, and it's backed up by HP's Wolf Security and a slim, all-metal chassis.

$2,209, hp.com/au-en

LENOVO THINKPAD X1 CARBON GEN 9

A business laptop with heaps of luxury, especially if you choose the top-end model with a 3,840 x 2,400 screen.

$2,389, lenovo.com/au

DELL XPS 13

Dell has updated the gorgeous XPS 13 with Intel's 11th-generation Core chips to great effect. The 13.4-inch screen, touchpad and solid keyboard are similarly sumptuous.

From $1,518, dell.com

EVERYDAY LAPTOPS

ACER SWIFT 3X I7

EXCELLENT PERFORMANCE AT AN APPEALING BUDGET PRICE

The headline feature of Acer's new Swift 3x is undoubtedly the fact that it features Intel's new discrete GPU – the Iris Xe Max Graphics. The Swift 3x is available through Harvey Norman as either an i7 with a 1T SSD, or a Core i5 model, with a 512GB SSD.

From $1,049, acer.com.au

ALTERNATIVES

LENOVO YOGA SLIM 7 PRO

A powerful, well designed ultrabook with an awesome OLED screen for a good price. The original 2-in-1 bends into a new clamshell shape.

$1,949, lenovo.com

HP ENVY 13 (2020)

It may not be the world's most exciting laptop, but the Envy 13 is a compact and forward-looking machine that's ideally suited to these homeworking times.

$1,699, store.hp.com

MICROSOFT SURFACE LAPTOP GO

A superb travelling companion, the Go offers all the power you need in a stylish and well-built 1.1kg chassis.

$1,179 microsoft.com

CHROMEBOOKS

ASUS CHROMEBOOK FLIP C436F

FLEXIBLE LAPTOP FOR $1,419

The Flip C436F is a fast, flexible laptop with a slim magnesium alloy chassis that's easy on the eye. With a 256GB SSD, a Core i5 processor and fantastic 14-inch Full HD screen, it's a fine choice for demanding users.

$1,419, amazon.com.au

ASUS CHROMEBOOK CX9

Aimed squarely at business users, this exceptionally quick machine – with a Core i7 processor, 16GB of RAM and a 512GB SSD – drips quality throughout its aluminium alloy chassis. Add a glossy 4K 14-inch screen, plus a low weight of just 1.05kg, and it justifies its high price.

$1,579, asus.com/au

LENOVO IDEAPAD DUET

The Chromebook answer to Microsoft's Surface tablets, this is a seriously versatile device – albeit not the speediest (although we never found it to be painfully slow while carrying out everyday tasks). For this price, and with a 16hrs 14mins battery life, the Duet is a great choice.

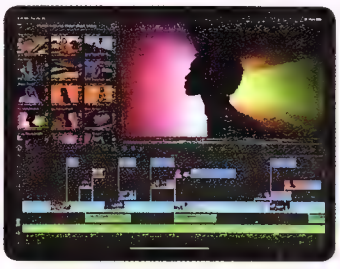
$447, lenovo.com/au

TABLETS

APPLE IPAD PRO 12.9IN (2021)

M1 POWER IN YOUR PALM FROM $1,199

Blurring the boundaries between laptop and tablet like never before, the M1-powered iPad Pro 12.9-inch is every bit as fast as we expected – and the "Liquid Retina XDR" display is simply phenomenal. **apple.com/au**



APPLE IPAD (2021)

Apple performs its usual trick of upgrading just enough to keep the iPad affordable and up to date, without treading on the toes of its more luxurious stablemates. The big bezels remain, but a faster processor, more storage and improved camera all add to its appeal.

From $449, apple.com/au

SAMSUNG GALAXY S8 ULTRA

The Samsung Galaxy Tab S8 Ultra is an enormously impressive tablet. It makes a fantastic first impression with its gorgeous screen and thin body, and is great for multitasking. If you want the best Android tablet going, there's no question at all that this is it.

$1,598, samsung.com

EVERYDAY MONITORS

PHILIPS BRILLIANCE 346P1C

34-INCH CURVED DOCKING,

No-one can match Philips for its mix of quality, features and value, especially when it comes to curved MVA monitors such as this. It's great for casual gamers and busy workers alike, with USB-C docking and superb colours.

$849, philips.com.au

EIZO FLEXSCAN EV2480

Businesses in particular will love this easy-to-roll-out 24-inch monitor, with its exceptional five-year warranty, USB-C port for easy docking, excellent viewing angles and delicious whites. And it has the best OSD around.

$699, eizoglobal.com

DAHUA DHI-LM28-F420

This affordable 4K monitor might not offer much in the way of menu options or high-end gaming perks, but it offers impressive resolution and colour for a fraction of the price you'd normally pay.

$269, dahuaaustralia.com.au

PROFESSIONAL MONITORS

EIZO COLOREDGE CG319X

CREATIVE MASTERCLASS, $7,119

As the price indicates, this monitor is for heavyweight creatives who demand the best in every discipline: HDR video editing, print layouts, professional photography and more besides. With superb coverage and accuracy across all spaces, plus a built-in calibrator, it justifies the investment.

$7,119, eizoglobal.com

BENQ PD2725U

By no means a cheap 4K 27-inch monitor – unless you compare it to the Eizos – but it marries all-round quality with ease of use thanks to a puck that allows you to quickly move between settings. You can even daisy chain a second Thunderbolt 3 monitor for a monster setup.

$1,799, benq.com

EIZO COLOREDGE CG279X

Designers who need to work across different disciplines will love how easy it is to switch between the Adobe RGB, DCI-P3 and sRGB colour spaces using the Eizo's fantastic OSD. It's certainly not cheap for a 27-inch 1440p monitor, but it's packed with quality.

$3,095, eizoglobal.com

HOME OFFICE PRINTERS

EPSON ECOTANK ET-1810

BACK TO BASICS

There's nothing flashy about this bottle- fed inkjet: it's there to churn out pages at a decent rate (8.8ppm for black text) for a low price. It comes with enough ink for 4,500 black pages and 7,500 in colour, but refills are cheap. Just don't expect features like duplex printing.

$299, epson.com.au

CANON PIXMA PRO-200

Yes, it's big and it's expensive – and you don't even get a scanner – but the Pixma Pro-200 means that you can print A3 photos with glorious colour accuracy and detail. If you're after an office workhorse, look elsewhere, but it can't be beaten on photo quality.

$809, canon.com

BROTHER MFC-J4540DWXL

Home workers will love this inkjet all-in-one. It combines an incredible range of features with all the connectivity you need and extreme ease of use. Output quality is fine, it offers the best cloud support around and the high-capacity ink pack could keep you going for years.

$420, brother.com

WIRELESS ROUTERS

SYNOLOGY RT6600AX
FAST & LADEN WITH UNIQUE FEATURES
Fast, well-featured and secure, the Synology RT6600ax is as perfect for professionals and prosumers as much as it is for SMBs and smart homes.
$599, synology.com/au

ASUS RT-AX82U
The impressive RT-AX82U punches well above its price when it comes to raw Wi-Fi 6 performance and includes a fistful of useful features – such as an ultrafast 20Gbits/sec USB connector, outbound VPN support, site-blocking and a host of parental controls.
$320, asus.com/au

HUAWEI WS7200
This affordable Wi-Fi 6 router delivers consistently fast wireless speeds, broad coverage and a modest speed boost for newer hardware – and the Router 3 has a cute design too. If you need more range, you can pick up a second unit to use as an extender.
$120, huawei.com

MESH WI-FI

TP-LINK DECO X90
SUPERB WI-FI 6 MESH
Welcome to the new generation of Wi-Fi 6 meshes, with greater range and consistent speeds for both upload and downloads. TP-Link reckons these two units will cover a six-bedroom house, and they each include 2.5GbE ports too.
$699, tp-ink.com

TP-LINK DECO X20
The price below isn't a typo: the Deco X20 makes it possible to upgrade your home network to Wi-Fi 6 – as well as manage its security – for the price of some standalone routers. The included HomeCare functions are also a great bonus for households where lots of devices are fighting over the bandwidth.
$199, tp-link.com

ASUS ZENWIFI AX
The interface and design certainly aren't the prettiest (the nodes look like mini space heaters, while the charcoal version is straight out of the 1980s), but if you're after strong performance, great features and plenty of expansion potential, the ZenWiFi AX is a compelling prospect.
$949, asus.com/au

NAS SERVERS

QNAP TS-130
SIMPLE HOME NAS
An above average CPU and RAM combo, solid features and affordable price make the QNAP TS-130 worth considering. Alternatively there's the two bay TS230 which features the same CPU, with 2GB of RAM, dual drive bays, and an extra USB port on the front for a modest $50 price increase.
$250, qnap.com

ASUSTOR NIMBUSTOR AS5304T
This is a hugely powerful four-bay NAS that will be overkill for most people – not just due to its speed but also its slightly intimidating user interface – but techies and gamers should investigate the Nimbustor AS5304T for both its speed and flexibility.
$799, asustor.com

SYNOLOGY DS1019+
This five-bay NAS includes many of the features that make the DS218+ to the left such an attractive buy: a superb selection of apps, an elegant hardware design and a good deal of power. And those five bays make it perfect for RAID5 configurations, or Synology's own Hybrid RAID.
$1,249, synology.com

SECURITY SOFTWARE

F-SECURE SAFE
F-Secure concentrates on the basics: faultless protection with minimal impact on your system's performance – for a low price.
1-3 PCs, 1yr, $99.99, f-secure.com

NORTON 360
Consistently on the podium in our group tests, and loaded with an abundance of genuinely useful features, including a VPN and generous cloud backup.
1 PC, 1yr, $79.99, nortonlifelockpartner.com

AVAST FREE ANTIVIRUS
For the second year running, Avast is our top pick for free antivirus software – it's simply lighter on its feet than Microsoft Windows Security, whilst offering fewer false positives.
Free, avast.com

VPNs

NORDVPN
NordVPN provides consistent and fast speeds, serious security, great support for video-streaming services and some cost-effective subscription rates.
$59 per year, nordvpn.com

PROTONVPN
ProtonVPN provided one of the best free offerings of all the VPNs in our group test, including unlimited data, but upgrade to benefit from even faster speeds and many more options.
Free, protonvpn.com

SURFSHARK
A strong rival to NordVPN, especially if you're willing to commit to its two-year contract. It's fast, cheap and a fine choice for people who like to switch to US streaming services.
$66.34 for one year, surfshark.com

PASSWORD MANAGERS

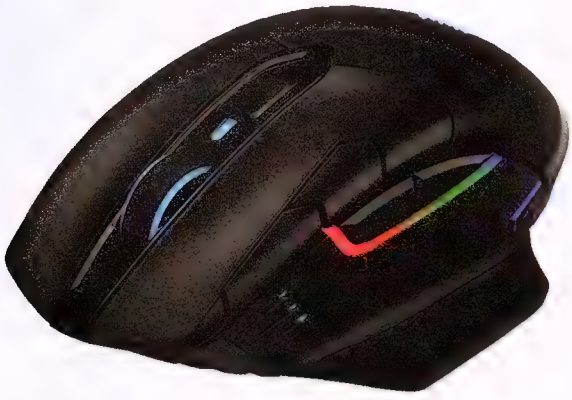
BITWARDEN
Bitwarden has a huge advantage: it's free. It isn't as slick as some paid-for rivals, but it can sync passwords across all devices for no extra charge. **Free, bitwarden.com**

DASHLANE
A manager that's ideal for beginners, and it even builds in an unlimited (if basic) VPN service. Note you may prefer to buy the Family plan ($60 per year) as this extends the service to six people.
$55.99 per year (Premium), dashlane.com

1PASSWORD
1Password is targeted at technically minded users who are looking for the last word in security. It even offers a Travel Mode that may ease your mind if surrendering your phone to customs officials.
$54.99 per year (individual), 1password.com

The top five wireless gaming mice

eSports players usually demand wired mice for reduced latency and improved responsiveness, but for everyone else, there are wireless mice. If you spend hours at your computer working or gaming, there's nothing quite like the luxury of being able to navigate unencumbered by a mouse cable. Our selection this month covers the best mice for comfort, features, and style, all across a range of budgets. Whether you're looking for your first wireless mouse or an upgrade, these are the ones to check out.



1

CORSAIR DARK CORE RGB PRO SE

Corsair's wireless mouse can also charge itself using a mouse mat, in this case, the Corsair MM1000. But it gets extra points because it's also Qi-compatible, meaning that if you don't want to buy a special mouse mat, you can just buy a cheap wireless charger or use the one you probably already own. The Dark Core RGB Pro SE looks great, has a brilliant 18,000dpi sensor and Bluetooth connectivity, making it the ultimate feature-packed mouse.

$140, www.corsair.com

2

LOGITECH G502 LIGHTSPEED WIRELESS

This is the ultimate wireless mouse flex – a mouse that charges itself while you're using it. You need the Logitech G Powerplay Wireless Charging Mat ($149), but you'll never have to worry about a dead mouse again. The G502 Lightspeed Wireless has a 16,000dpi sensor for incredible accuracy, customisable buttons, and 2g and 4g weights that can be added if required.

$190, www.logitechg.com

3

RAZER DEATHADDER V2 PRO

Razer's mouse has that reassuring feel of quality you expect from the brand. It's not lacking in features, with 70 hours of battery life, HyperSpeed wireless tech, and a button on the base to switch between custom profiles that adjust sensitivity and RGB lighting. Unlike the Logitech G502 mouse, it doesn't have an infinite scroll wheel and won't charge over Qi or a specialised mouse mat.

$120, www.razer.com

4

ROCCAT KAIN 202 AIMO

Roccat's mouse wins in terms of accuracy with its 19,000dpi sensor, although bear in mind you can't change that if it's too responsive for your tastes. On the plus side, it boasts both 2.4GHz Wireless and Bluetooth connectivity, making it perfect for running double duty across desktop and laptop computers. It's also pleasingly lightweight, has a distinctive honeycomb RGB lighting, and, overall, feels built to last.

$140, www.roccat.com

5

HYPERX PULSEFIRE DART

HyperX has a track record of making great products at a competitive price, a tradition we're pleased to see has been continued with the Pulsefire Dart. It features one of the simpler designs of the mice on test here but it feels great to use, has an incredibly responsive 16,000dpi sensor, and will charge using a Qi wireless charger if you have one, or a cable if not. It even has RGB lighting, which is controlled via HyperX's software.

$130, www.hyperxgaming.com

HEAD TO HEAD

LastPass vs. Bitwarden

Which password manager is better?

■ LASTPASS | LastPass Free $free, LastPass Premium US$36/year, LastPass Families US$48/year | www.lastpass.com
■ BITWARDEN | Bitwarden Free $free, Bitwarden Premium US$10/year, Bitwarden Families US$40/year | www.bitwarden.com

While the world's leading technology companies are finally vowing to put an end to passwords by using a smartphone-based PIN, fingerprint, or face unlock, passwords remain essential for now. Google Chrome and Windows Credential Manager will perform the basics of remembering your passwords and suggesting secure logins, but that quickly becomes a problem if you frequently switch platforms or software. If you use more than one device, as most people do, then a password manager is the answer, as it works across platforms and syncs between devices. The result is that you never have to remember a password again, other than the one you use to access the password manager, of course.

Having had the password manager conversation with friends at dinner parties (yes, we are that person), we can already feel the eye rolls – and we get it. Moving to a password manager and then remembering to use it is a pain at first. But security is such an important part of your digital life that once you make the leap, you'll soon wonder how you managed without one.

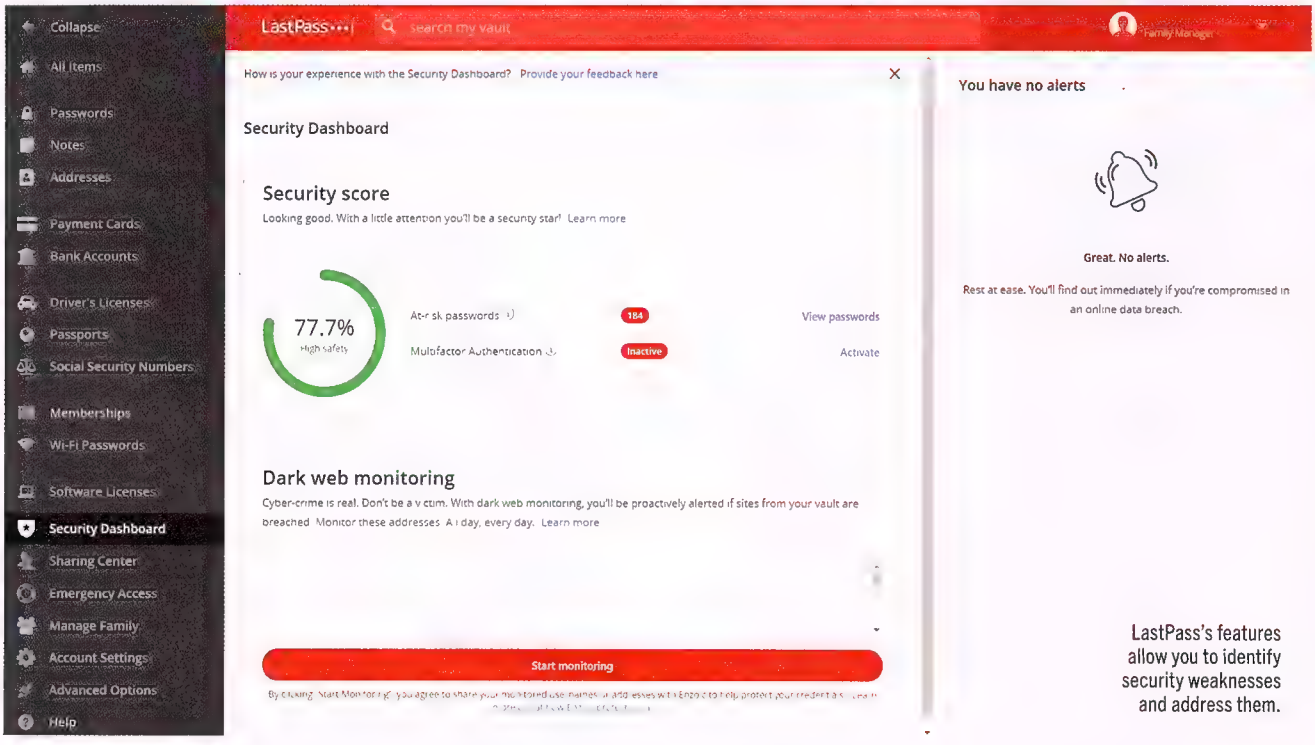
On their most basic level, password managers do exactly what they say on the tin – they store and manage your passwords. But it's the extra bells and whistles that make them essential. They integrate with browsers like Chrome and operating systems, such as Android and iOS, and automatically fill in login information on sites and apps you've used before while suggesting new unique passwords for those you haven't. They can also be used to store sensitive information beyond just passwords, such as credit cards, ID information, and private notes.

There are plenty of password managers to choose from and, although we only cover two here, we'd also recommend checking out NordPass pr 1Password if you're in the Nord ecosystem or a Mac user, respectively. Here, we focus on two of the most popular options: LastPass and Bitwarden.

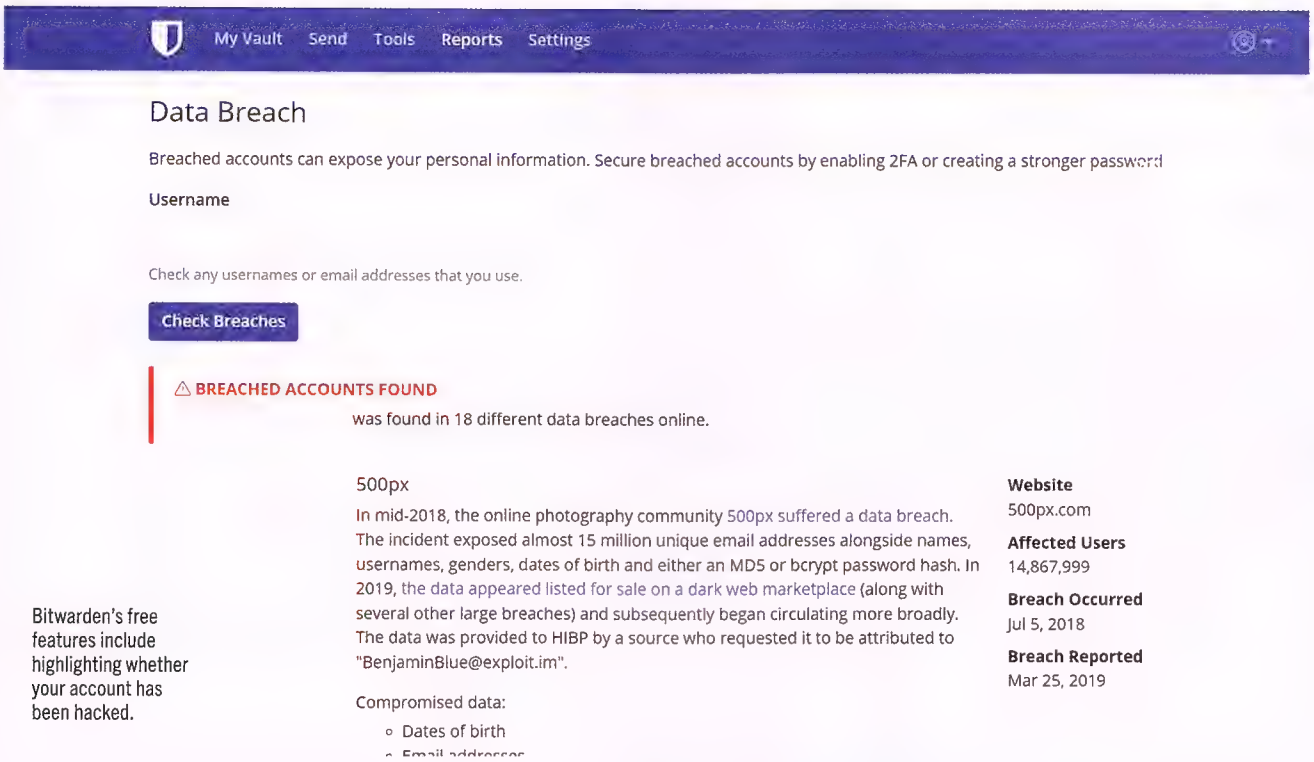
Until last year, LastPass was the de facto choice for many because it was really good and also free. It's still really good, but sadly no longer free, as LastPass now charges users if they want to access their database on more than one type of device (free users can only do computers, or only do mobile devices), which makes it useless for most. LastPass Premium, which unlocks this feature and adds more features, is US$36 per year (equivalent to US$3 per month), while Families, which lets you share Premium features between up to six people, is US$48 per year (US$4 per month).

If a piece of software is well made and/or valuable, then it's definitely worth paying for, and LastPass is certainly both. But if all you need to do is securely store and access passwords across a variety of devices, Bitwarden will do that for you for free, which makes it an immediate winner for most. To justify paying out for LastPass Premium, you will need to take advantage of its advanced features, which include emergency access plus a security dashboard with dark web patrolling. There's also 1GB of encrypted file storage, but Sync.com offers that for free.

LastPass's security dashboard is worth deploying once or twice a year, as it will alert you to any passwords that may have been compromised, or any that are being duplicated across multiple services. Of course, the more you use a password manager, the more unique passwords you should end up



LastPass's features allow you to identify security weaknesses and address them.


My Vault
Send
Tools
Reports
Settings
Data Breach
Breached accounts can expose your personal information. Secure breached accounts by enabling 2FA or creating a stronger password
Username
Check any usernames or email addresses that you use.
Check Breaches
BREACHED ACCOUNTS FOUND
was found in 18 different data breaches online.
500px
In mid-2018, the online photography community 500px suffered a data breach. The incident exposed almost 15 million unique email addresses alongside names, usernames, genders, dates of birth and either an MD5 or bcrypt password hash. In 2019, the data appeared listed for sale on a dark web marketplace (along with several other large breaches) and subsequently began circulating more broadly. The data was provided to HIBP by a source who requested it to be attributed to "BenjaminBlue@exploit.im".
Compromised data:
Dates of birth
Website
500px.com
Affected Users
14,867,999
Breach Occurred
Jul 5, 2018
Breach Reported
Mar 25, 2019

Bitwarden's free features include highlighting whether your account has been hacked.

creating, and the less duplication becomes an issue, but LastPass can also auto-change passwords on websites such as Facebook and Amazon just to add another layer of security. Emergency access is another modern-world essential, as it allows you to set access permission for certain contacts either immediately or after a period of time.

This means that, if the worst happens and you're in an accident or otherwise unable to access important information such as medical records, financial accounts, or anything else that unforeseen circumstances might require, your next of kin can obtain your details instead.

These are great features for LastPass, but the problem is Bitwarden also has equivalents in its premium offering, which is priced at a much more competitive rate. Bitwarden Premium is just US$10 a year for an individual who wants emergency access and security reports, rather than the US$36 annually for LastPass. Bitwarden Family, which again offers premium features to up to six users, is US$40 compared to LastPass's US$48 offering. All of this means that you're probably better off starting out with Bitwarden, which has a free offering with enough features for most people, while its premium features are cheaper if you need them later.

So, is there any point in going for LastPass? As you'd hope from the premium price, it feels like a more premium product. The main difference is that there's more granularity to categories, with separate listings for bank accounts and payment cards, whereas Bitwarden only has cards. LastPass also has separate sections for Wi-Fi passwords, addresses, and memberships, basically, any information that you need securing, LastPass will do it. We also preferred LastPass's security reports, which break down how well you're doing overall and make it easy to address any potential issues.

> "Ultimately, these are two good password managers that nail the basics while offering some excellent features to justify their premium price tags."

Bitwarden, while more basic overall, still has its benefits. If you're a power user and would prefer to control where Bitwarden stores its information, then you can host it on your own network or server, which is free to do no matter what plan you're on. Its simplicity also makes it easier to use overall, as you can manually add banking details as a secure note in your banking login details, meaning it's all in one place. However, we found Bitwarden's Chrome plugin annoying to use, as it would freeze when typing in search terms, meaning it would miss letters and then not find the correct information.

Ultimately, these are two good password managers that nail the basics while offering some excellent features to justify their premium price tags. LastPass in particular is easy to use, while the organisation freaks among you will love having your entire life's worth of private information to hand in an emergency. Once you have your passport information stored digitally in a secure vault, the idea of having to root around for your physical passport when booking a flight seems archaic.

As it stands though, we recommend you start with Bitwarden, whether you're new to the password manager game or you already have a password manager you're paying for without taking advantage of the advanced features. All of these password managers make it easy to export your data from one service to another, although do remember to encrypt the exported CSV or JSON files if possible, and properly delete the local file and your old vault when you're finished.

LastPass Easy-to-use with excellent categorisation and great security reports.
Guy Cocker

★★★★☆

Bitwarden Free tier actually useful and the premium tiers cost less than LastPass's equivalent.
Guy Cocker

★★★★½

TECHNOTES

Gadgets

Nice little things

❶

GOPRO HERO10 BLACK BONES

Fort the GoPro enthusiast that takes to the sky.

$749.95 | gopro.com/en/au

Weighing in at just 54 grams, GoPro's latest Hero 10 Black Bones is about a third the weight of the regular, already very light, Hero 10 Black. Now GoPro wasn't just padding its flagship camera with lead weights, so there's a fair bit that's been ditched in this bare Bones edition. The most notable omission is the battery, since the camera can now be powered by your custom drone via leads, but there's also a heap of audio and features that have been jettisoned. The camera does keep its lens, 5K image sensor, GP2 Processor and HyperSmooth 4.0 tech, however. Making it a pretty impressive FPV drone camera.

❷

GRAVITY INDUSTRIES JET SUIT

You can now buy your own fully functional jetpack.

$TBC | gravity.co

You've probably seen the absurd Gravity jetpack suit grace the pages of *APC* before, but this ridiculous levitating Ironman suit is now something that you can actually pay hard earned money to own. Yep **Gravity.co** is taking orders for custom Jet Suits on their website. We have no idea how long they'll take to make or exactly how much they'll cost, but we do suspect you might have to part with your Bored Ape Yacht Club NFT in order to finance it. Anyway, if you are lucky enough to not really need another Tesla then we implore you to fill it up with jet fuel and fly it over to the *APC* office to give us a go.

❸

DAMON HYPERSPORT

Putting the e's in need for speed.

US$40K | damon.com

If you're depressed by the financial and crypto market downturn, but you happen to have a spare fortune lying around because you went long on oil just before Russia decided to implode international relations in Europe, then we have just the gadget for you. The Damon Hypersport is a speedy little electric motorbike demon that will allow you to pull babes and offset a tiny portion of the environmental damage caused by those big barrels of compressed prehistoric ocean fauna that you sold for a massive markup. With a top speed of 320km/h, a 320+km range and 0-100 acceleration in under three seconds, your conscience doesn't stand a chance of catching up.

4

COMMODORE 64X ULTIMATE

A new(ish) PC in a very old package.

£827 | kck.st/3QjwBPM

Nostalgia can be a powerful thing. It can trick you into thinking that the ice creams of your childhood were much better than anything available today, or make you think that you might like to watch *Waterworld* again some day... heck it's even seemingly powerful enough to trick 396 diehard Kickstarter HODLers to overpay for a gaming PC that comes in the shape of a Commodore 64. Since I was only four when the 64 was discontinued, I can neither confirm nor deny if it was any good, but based on how colleagues reminisce about their 170KB floppy disk drives I'm assuming at least some of you really want to play games in a command line again.

5

DYNABOOK THUNDERBOLT 4 DOCK

Go big with your displays.

$429 | anz.dynabook.com

With multi-monitor setups and Thunderbolt 4 both increasing in popularity and capability, a proper dock is what you need if your laptop or PC is lacking sufficient ports. This generously-specced box supports up to four 4k displays or a single 8k display, via a pair of DisplayPort outputs, along with another pair of HDMI ports. Transfer speeds of up to 40 Gbps make it all possible, and that's handy to have for data transfer if you're not into surrounding yourself with displays. The ports can also be used for speedy laptop charging, with a healthy 90W of power on tap. 3Xc USB 3.0 and ethernet ports are also included.

6

HUAWEI WATCH D

Pump it up, for your heart.

$799 | huawei.com/au

As smartwatches expand their capabilities, we're seeing some genuinely innovative and useful features being added. The new Huawei Watch D is all about your blood. Along with the usual smartwatch monitoring of your heart rate, the Watch D can measure your blood pressure. To do this it comes with a removable and replaceable (if it wears out) airbag that lines the inside of the band. A tiny motor inflates the bag and the watch then calculates your blood pressure. The band only needs to be attached for the reading, and is removed for comfort when you're not doing a test.

REVIEWS

THE HOTTEST GEAR LABS TESTED

TABLET

Lenovo Tab P12 Pro

A powerful but pricey Android tablet.

■ $999 | www.lenovo.com

Lenovo has some of the best Android tablets available today. The Tab P12 Pro is a good one, but it falls short of greatness, as an awkward middle child between the company's premium and mid-range efforts.

If you close your eyes and picture your average tablet, the image that pops up probably would look pretty similar to what the Lenovo Tab P12 Pro actually looks like. Compared to some other tablets currently on the market, this Lenovo has a fairly wide screen. Its dimensions are 285.6 x 184.5 x 5.6mm (yes, it's really thin) and it weighs 565g. There's a fingerprint scanner and volume rocker, and also a USB-C port – but no 3.5mm headphone jack, which we'd have liked to see.

Because the tablet is pretty thin, we'd recommend buying a case for it – we felt squeamish about putting it in a backpack unprotected. The bezels are fairly thin – this is quite a svelte tablet – with the front-facing camera embedded at the top (if you're holding the tablet landscape). On the back, there's a camera bump that's fairly big for a tablet, and a magnetic strip that holds (and charges) the stylus. Unlike on some tablets, where the stylus can only be laid on a specific spot, you can slap the Lenovo's stick on quite a wide area, which is really handy when you're in a rush

The Lenovo Tab P12 Pro has a 12-inch display. This panel has a 1600 x 2560 resolution – that's 2K – as well as a 120Hz refresh rate, support for HDR10+ and Dolby Vision, and comes in a 1.6:1 aspect ratio. It's a really good screen with vibrant colours and great contrast, even when you compare it to the Samsung tablets it's going head-to-head with. The maximum brightness is a little limited at just 600 nits, but you're unlikely to be using a tablet like this in direct sunlight much.

> "It's a really good screen with vibrant colours and great contrast, even when you compare it to the Samsung tablets it's going head-to-head with."

The Lenovo Tab comes with the Snapdragon 870 chipset – this was initially created as a 'light' version of 2021's top-end Snapdragon 888, but quickly became a go-to component for companies wanting to offer a powerful chip for a relatively low price.

We found the tablet to be good for gaming, even though many rival tablets come with more than the 6GB RAM available here. Because of the slate's screen, the P12 Pro could be a good option for cloud streaming services like Xbox Cloud Gaming, though it's just as good for fast-paced titles like *Call of Duty: Mobile* or slower ones like *Total War: Medieval II*.

The stylus experience here is good, but not great: it's the running theme here.

There doesn't seem to be too much pressure sensitivity with the stylus, and it feels like there's quite a bit of resistance when simply swiping the tip along the display. Don't get us wrong, we're glad that Lenovo is bundling its stylus instead of making you buy it separately, but we did find ourselves wishing for the Apple Pencil a little when testing the P12 Pro stylus.

As it stands, the Lenovo Tab P12 Pro isn't exactly a super-functional work/play beast like some other tablets are – but it's not awful for such uses either.

The Lenovo Tab P12 Pro is good, but it's not great – especially in the cut-throat Android tablet market.

Tom Bedford

★★★★☆

AIO PC

MSI Modern AM242P

MSI's sleek all in one PC has everything the modern worker needs to crunch the numbers.

■ $2,099 | au.msi.com

If you're not an architect or an in-demand graphic designer, then justifying the latest Surface Studio from Microsoft might be a stretch, but all all-in-ones don't have to break the bank. These sleek, clutter-free computers can be really affordable and make a lot of sense for a whole range of workflows.

Take the Modern AM242P from MSI for example. This unit is exclusively sold at JB Hi-Fi for either $1,899 or $2,099 depending on whether you chose an 11th Gen Intel i5 or i7 model. Both these units come with a 23.8-inch Full HD IPS display, a 2TB HDD and 16GB of RAM, but the entry model gets a 256GB SSD while the latter gets a slightly bigger speedy internal SSD at 512GB.

While this unit is much more approachable than something like the Surface Studio 2 it is actually a lot more expensive than its sibling the MSI modern AM271P, which is sold at various other outlets. The Modern AM271P comes in various configurations, but with 8GB of RAM and no HDD (you can add your own in the easy access drive bay). And while the AM271P has a much bigger 27-inch 1080p display, it is available for just $1,297 at Officeworks.

The Modern AM242P is a tad more sleek than its better-value sibling since it has an integrated HD webcam and all the units come with a simple wireless keyboard and mouse that most people should find good enough to work on. If you're used to mechanical keyboards and mice with high polling rates however, you may want to consider keeping these as a backup set as the included combo is pretty rudimentary.

The 1080p monitor itself looks nice with almost bezelless edges on the top three sides and you probably wouldn't even realise this monitor actually includes a computer just by looking at it since the components fit into a neat package on the lower rear half of the screen.

■ Windows 11 Home; 23.8-inch IPS display at 1920x1080 pixel resolution; Intel Core i7-1165G7 CPU; Intel Iris Xe Graphics; 16GB RAM; 512GB PCIe SSD; 2TB HDD; 54.1x19.5x53.5cm; 6.16kg.

While the square base doesn't look quite as elegant as the thin legs on the Modern AM271P, it does provide more stability, allowing it to be adjusted to the height and angle that's most comfortable.

There is an onboard microphone and speaker set, which is a lot more than most desktop monitors you see on the market, however they're both really basic and too quiet. You should be able to get through the odd YouTube video, but you'll probably have to yell if you want to be heard on a conference call.

> "The 1080p monitor itself looks nice with almost bezelless edges on the top three sides."

The performance of this CPU range was not bad back in 2021 when it was current, but don't expect it to keep up with 2022 PCs. That said, even 11th Gen quad-core i5 and i7 processors are great at running a spreadsheet and with 16GB of RAM you'll be able to crank a heap of Chrome tabs.

The Intel Iris Xe Graphics even means you'll get just playable performance from slightly older games using Low 1080p settings and there's enough graphical grunt for a range of creative workflows too.

	MSI Modern AM242P 11M	(2021) Asus ZenBook Duo UX482
Specs- CPU, GPU, RAM	i7-1165G7, Intel Iris Xe, 16GB	i7-1165G7, Intel Iris Xe, 16GB
PCMark 10 - Overall (score)	4,310	4,854
Cinebench R23 - CPU (multi-core)	5,230	3,732
HWBot x265 - 1080p (fps)	27	21
Peak CPU temperature (°C)	82	96
3DMark - Time Spy (Score)	1,189	1,817
CrystalDiskMark Read (MB/s)	3,186	3,513
CrystalDiskMark Write (MB/s)	1,515	2,994

A sleek all in one with a few imperfections and a padded price tag.

Joel Burgess

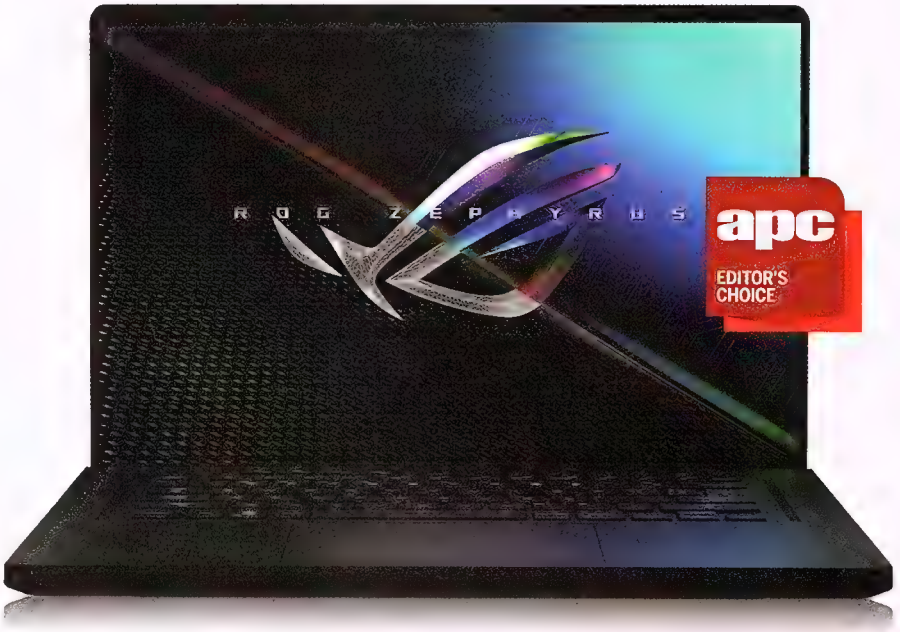
★★★½☆

ULTRAPORTABLE LAPTOP

Asus ROG Zephyrus M16

Asus' Intel-based premium Ultraportable gets a decent processor rejig, but is it worth the additional cost?

■ $4,499 | rog.asus.com/au



The last couple of Zephyrus Ultraportable gaming laptops we've seen from Asus have been built around AMD CPUs, so it's interesting to see that the 2022 ROG Zephyrus M16 has an Intel processor kicking things off. There's a major difference in Intel's 12th gen, H-series CPUs since they have 14 cores, rather than the eight cores you see on the 11th generation H-series processors. The array is split into eight efficiency cores and six high performance cores, which might seem like an exchange that'd give you similar results, but for many general work tasks it actually dramatically improves the overall performance and helps reduce the device's battery drain under less intensive workloads.

The ROG Zephyrus M16 is a refresh of Asus' 2021 ROG Zephyrus M16 that sticks pretty close to its predecessor. It's got a similar 16-inch display in a 15-inch form factor, with the same optional 16 by 10 QHD+ screen, wrapped in an almost identical 2kg chassis.

The updated 2022 Zephyrus M16 comes with either an Intel Core i7-12700H or an Intel Core i9-12900H processor. The former is paired with a 165Hz FullHD+ 16:10 display, 16GB of RAM and a choice of a Nvidia GeForce RTX 3050 Ti (100W) GPU for $2,799 or a RTX 3060 (120W) GPU for $3,199. If you opt for the i9 model, you'll get that higher res 2560 x 1600 165Hz screen, a larger 32GB RAM allocation, and an RTX 3070 Ti (120W) GPU for $4,499.

For a reduced range, the configurations are pretty nicely balanced, even if we do wish that all of them got the QHD display. In addition to being higher resolution the QHD+ display also offers a professional level DCI-P3 wide colour gamut for colour grading or high-fidelity HDR gaming, rather than the standard 100 percent sRGB colour on the 1200p monitors.

■ Windows 11 Home 64-bit; 16-inch 165 Hz display at 2560x1600 pixel resolution, 100% DCI-P3, 3ms response time; Intel Core i9-12900H CPU; Nvidia GeForce RTX 3070 Ti (120W) GPU; 32GB RAM; 2TB SSD; 90Wh battery (4h28min 1080p movie playback); 35.5 x 24.3 x 1.99cm; 2kg.

The metal chassis with 'soft-touch' coating gives a premium feel to the device and the generous trackpad, quiet keyboard, and subtle colour on the top shell continue a level of sophistication that is often missed on gaming laptops.

The Zephyrus M16 may be design conscious, but it's also got good performance stats for a gaming ultraportable. The i9-12900H CPU model we tested was between two and 20 percent better than the average we currently have for a i7-12700H, although the take this with a grain of salt since the i7-12700H performance can vary considerably across different laptop brands and chassis. Regardless this powerful processor will be exceptional for any work or gaming tasks.

The Nvidia RTX 3070 Ti GPU that we tested was allocated a 120W max power draw, which is a reasonable middle ground offering around 15 percent more performance than a 3070 Ti with a 95W TDP, but about 10-15 percent less than the same 3070 Ti offered on bulkier gaming laptops with 150W GPU power allocations. This translates to 90fps+ on modern titles using 1080p Ultra settings and around 60fps+ when using ray tracing or at higher resolutions. Expect about half this graphical performance if you opt for the 3050 Ti GPU or about 20 percent less for the 3060 GPU.

While battery life was improved thanks to the CPU, general work tasks and 1080p video won't get you more than 3-4 hours respectively. The one main downside is that there's been a $100 price increase from its predecessors on the low-end units and it'll cost $1,100 more for the i9 model this year.

	Asus ROG Zephyrus M16	Asus ROG Zephyrus G15 GA503Q
PCMark 10 - Overall (score)	7,208	7,190
Max CPU Temperature (C)	100	96
1080p movie playback (HH:MM)	4h28	6h38min
Cinebench R23 - CPU (Score)	15,483	11,489
3DMark Time Spy (score)	9,528	10,024
The Division 2 - 1080p Ultra (fps Av.)	84	83
CrystalDiskMark Read (MB/s)	7,089	3,594
CrystalDiskMark Write (MB/s)	5,285	3,033

A sleek gaming ultrabook with great performance with a slightly inflated price point.

Joel Burgess

★★★★½

PORTABLE DISPLAY

Asus ZenScreen Go MB16AWP

Asus's portable monitor goes full wireless, with no strings attached.

■ $752 | asus.com/au

■ 15.6-inch IPS display at 1920 x 1080 pixel resolution; 250nit brightness; 1200:1 contrast ratio; 2 x USB Type-C, 1 x mini HDMI, 1.3.5 mm audio; 7800mAh battery; 35.8 x 22.5 x 1.2cm; 1.09kg.

It's been a few years since we tested out one of Asus's ZenScreen Go portable monitors, and while the 15.6-inch screen size, Full HD display resolution and 7800mAh battery life haven't changed between generations, there's actually quite a few technological improvements behind the scenes.

The most significant is the addition of universal wireless display technology. While it might seem like you've been able to cast for aeons, all the different technologies can be expensive and it's a lot of work to configure all of them in the one device. We've seen plenty of projectors and portable displays opt for just iOS and MacOS or Android and Windows, whereas here you can use and easily swap between whatever device is on hand.

We tested the wireless connection using a Windows 11 system and the wired connection via USB-C on Windows 10. Historically, you'd see a little lag in your cursor or an irritating lack of responsiveness in a casting scenario, especially when doing something high pace like gaming, but the Asus ZenScreen Go was responsive and didn't show any perceptible lag thanks to the faster Wi-Fi, Miracast, and AirPlay protocols.

> "The Asus ZenScreen Go was responsive and didn't show any perceptible lag thanks to the faster Wi-Fi, Miracast and AirPlay protocols."

This effectively means one less cable to carry around, although it's probably a good idea to have a backup connectivity option in case you do have connectivity issues. When you do use the included USB-C cable or the HDMI to miniHDMI adapter you'll get the full 5ms response time and a guaranteed uninterrupted connection, so it's a worthy safety net.

The screen has also been upped to 250 nits from 220 nits on its predecessor, which makes it equally as bright as many of today's professional laptops. This should make the transition from screen to screen less noticeable for anyone using it as a portable dual-screen setup, but it will impact battery life a little since the ZenScreen Go has the same size 7800mAh battery as its predecessor. Still, Asus claims it'll last 3.5 hours with the volume right up in Wi-Fi mode, and that seems a reasonable estimate for all of the display presets with the brightness high.

This device does come with full sRGB certification and a preset that'll allow you to run in an accurate SDR colour profile. It's not enough for professional colour grading, but it is bright enough to be a handy tool for anyone that wants as consistent colours as possible.

The screen will turn off automatically after about 30 minutes to save power and with two USB-C connections, a Mini HDMI port and a 3.5mm audio jack there's enough physical interface options for the screen's intended use cases. The rear kickstand is fine, but power users might want to invest in a tripod stand to raise it up a little. Either that or just attach it to your camera tripod via the standard quarter-inch thread at the rear.

The Wi-Fi model doesn't include touch capabilities, if you do need that you'll have to look to the ZenScreen Touch model instead.

Asus continues to evolve its excellent portable display range.

Joel Burgess

★★★★☆

GAMING MONITOR

BenQ Mobiuz EX3210U

Can the big brother of one of our favourite monitors deliver a better bang for buck?

■ $1,699 | www.benq.com

■ Panel Size: 32-inch; Panel tech: IPS; Native Resolution: 3,840 x 2,160; Response time: 1ms MPRT, 2ms GtG; Refresh rate: 144Hz; Contrast: 1,000:1; HDR: HDR10, VESA DisplayHDR 600; Colour coverage: 98% DCI-P3; Brightness: 600 nits; Inputs: DisplayPort 1.4, 2x HDMI 2.1; Other: FreeSync Premium Pro, 2.1 speakers, IR remote, RGB rear lighting, Blue Light filters, 4x USB 3.0 KVM USB hub.

Back in issue 505 we reviewed BenQ's impressive EX3210R curved, 31.5-inch, UHD gaming monitor that generally succeeded at being all things to everyone. Now, here's the flat, similar-sized EX3210U, which costs almost double. What gives?

Firstly, the half-inch wider IPS screen ups the 2K resolution to a full, 4K, 3,840 x 2,160. There's also a built-in noise-cancelling microphone, which generally functions well, but is slightly muddier than most, modern laptops. The small, responsive remote returns to make accessing the numerous settings and picture quality tweaks relatively simple... which is just as well...

In terms of performance, our PC displayed a crisp and clear Windows Desktop although colours were rather washed out and smaller fonts could exhibit coloured fringing. The latter was often exacerbated when the display options were tinkered with.

Multimedia and video were kept sharp by the well-lit, high-resolution screen. We were also impressed with its colourful and monochromatic transitions which were smooth and only marginally blighted by blocky aberrations when upscaling content. Motion performance was also impressive with fast objects being rendered silky smooth thanks to the 144Hz refresh rate and fast pixel response time.

However, we continually struggled with colour vibrancy and contrast. Despite supporting HDR10, DisplayHDR 600 and utilising a backlight with (unspecified) local dimming technology, using any combination of the more-standard display adjustments left us with a generally washed-out image. We've mocked BenQ's (artificial HDR) 'HDRi' technology in the past but cycling between the three modes (Game, Cinema and Display) sometimes addressed an issue better than leaving it turned off.

The problem was that matching the requirements of different scenes with the most-suitable HDRi mode was like fitting a too-small carpet into a room – either colours or contrast suffered each time. If you stick to a certain type of game, you'll be able to tailor the picture just so. But, if you flit between different types of work, movies and games, even the quick-fix settings won't stop you getting frustrated.

We were pleased to see the 2.1 speakers again. These are generally loud and impressively punchy with good fidelity from top to bottom. Various audio pre-sets let you tailor frequency response to suit racing-car engines, music, snipers sneaking up on you, cinema or sports.

Connectivity is great thanks to two HDMI 2.1 ports and a four-port USB hub. The latter acts as an excellent KVM switch between, say, a home PC and work laptop – you just need to swap a single USB cable to keep using the same peripherals.

We found little wrong with the EX3210R which was great for the $799 price point. However, at $1,699, the EX3210R requires harsher scrutiny and, ultimately, we prefer the cheaper model. No matter what we were doing, we struggled to find the perfect combination of settings to suit our viewing requirements. If you want the 4K resolution, have the patience for the required picture tinkering and will often be playing the same games, it's a decent buy. But, our constant frustrations mean we can't recommend paying the premium.

A potentially great 4K gaming monitor is hampered by haphazard colour and contrast performance.

Nick Ross

★★★☆☆

MONITOR

Fujitsu Display P2410 TS Cam

Does this office all-rounder belong on your desk?

■ $648 | www.fujitsu.com/global

■ Panel Size: 24-inch; Panel tech: IPS; Native Resolution: 1920 x 1024; Response time: 5ms GtG; Refresh rate: 60Hz; Contrast: 1,000:1; HDR: no; Colour coverage: 99% sRGB; Brightness: 250 nits; Inputs: DisplayPort 1.2, HDMI 1.4, USB-C (with DP), 3.5mm audio jack, Gigabit Ethernet; Other: twin, 2W speakers, Full HD webcam with Windows Hello and privacy detection, Blue Light filters, 3x USB 3.2 KVM USB hub.

It's been a while since we've tested a Fujitsu monitor, so we were pleased when the pluckily named Display P2410 TS Cam turned up. Designated for SOHO and small enterprise, it offers some evolutions of familiar features plus a few new bells and whistles to make employees more productive and more comfortable. So, will organisations be buying it by the crate?

Setting up the 24-inch monitor is simple thanks to the should-be-mandated-by-law, three-step, tool-less design, which sees the stand snap effortlessly into the screen and the base connect via a single screw. The latter has a small, round footprint to both reduce desktop real-estate requirements and facilitate multi-monitor tiling. Inserting the (potentially many cables) is relatively simple thanks to 90-degree rotation plus generous 15cm height adjustment, 345-degree swivel and -5 /+35 degree tilt.

The ability to easily wrestle the screen into a wide variety of positions doesn't just suit IT engineers and OH&S professionals, it assists with standalone video conferencing. Above the screen is a Windows Hello-compatible, Full HD webcam which can be used with a partnering microphone array (with direct or omnidirectional modes) and twin, two-Watt speakers for web conferencing. To be frank, we've seen better performance on most modern laptops, but the grainy image is still usable even in relatively low light. Audio input is clear but the speakers don't get particularly loud. Not surprisingly they prefer vocal ranges over complex multimedia.

The camera comes with a hardware privacy slide, so you know that you're not being watched. However, it can also sense faces and activate privacy measures if someone snoops up behind you. It can also lock your computer automatically when you step away from it and unlock it via Windows Hello. If a camera isn't essential, Fujitsu has the otherwise identical P2410 TE for $568.

There's an Ethernet port at the back, but you still need a partner PC to make conferencing work. However, this is rendered relatively simple due to extensive KVM functionality whereby a USB-C port can be used for video input and laptop charging (up to 95W) simultaneously. It also means you can rock-up with a work laptop (with no charger), connect via USB-C and make use of the three-port USB-A hub (for keyboard and mouse) and Ethernet cable which stay connected to the monitor. It's great for hotdesking. Our only gripe is the OSD which seems to come from the 1990s.

In terms of screen performance, the Full HD panel is certified with all manner of Low Blue Light and Flicker-Free certifications and is very comfortable to work on for extended periods. Even video-watching is half decent thanks to above-average colours, smooth transitions and decent contrast. The 60Hz refresh rate and low-pixel response time suit only the most-casual of gamers, though.

Businesses will like the long product lifecycle and low-power consumption ratings. However, in world of decent corporate laptops and professional, office Unified Communications set-ups it's worth asking, how many workers really need such features? At $648 it's very expensive for individual buyers and while bulk buyers negotiate their own price, it's worth noting that corporate rivals from HP, Lenovo and Samsung are almost half that price.

Some interesting features, but if businesses really need this niche product, there are plenty of cheaper, rival models available.

Nick Ross

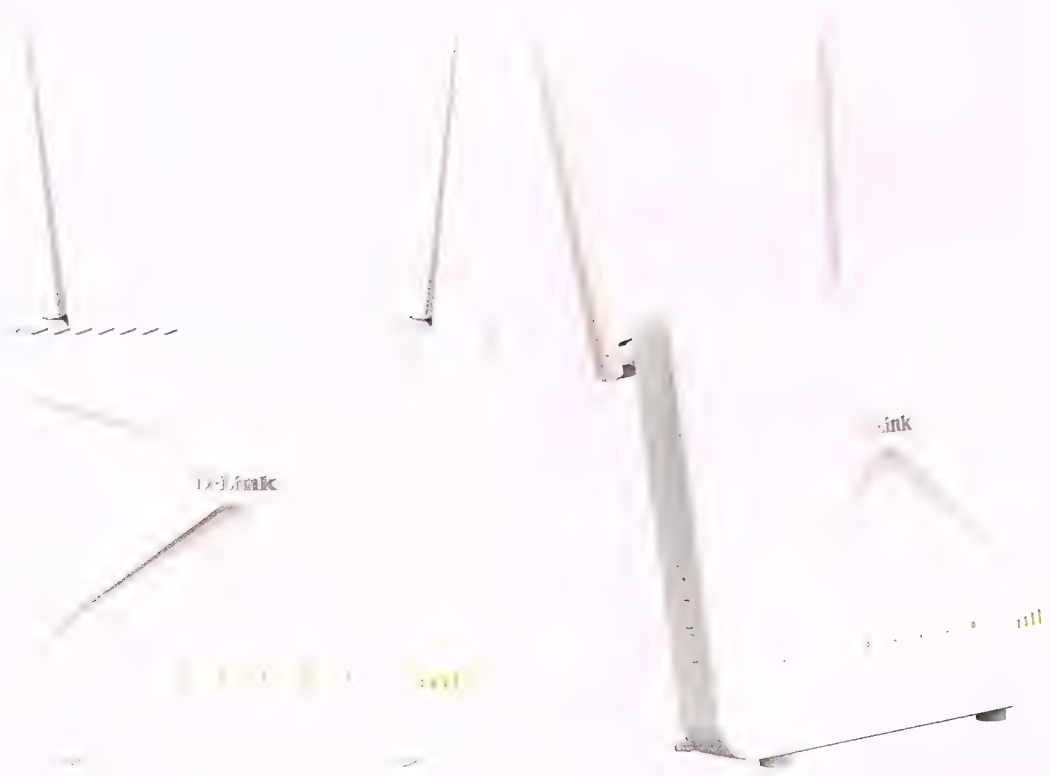
★★★☆☆

4G ROUTER

D-Link EaglePro AI AX1500 4G

D-Link's EaglePro Wi-Fi mesh system was one of the worst products we'd ever tested. How will its 4G sibling fare?

■ $300 | www.dlink.com.au



■ Speed: AX 1,500Mbps; Connectivity: 3 x Gigabit LAN, 1 x Gigabit WAN; 4G LTE CAT4 150Mbps with full-size SIM slot; Features: Family controls, 4G Failover, Google Assistant and Alexa support.

We shuddered when we realised that D-Link's new 4G Wi-Fi 6 router was from the same EaglePro AI family as the horrendous M15 we reviewed in issue 505. We hoped this would be better.

We're fans of the 4G Wi-Fi router concept as the technology can help share decent internet connectivity to a whole small business, or remote work location, where the wired infrastructure is poor. While we're a little disappointed that it doesn't support 5G, the fact it's the first 4G model to support Wi-Fi 6, that we've seen, is a definite boon.

We ran through set-up with bated breath... we downloaded the app; scanned the QR code on the router; were given prompts for two different, but identically named 'devices' to connect to; picked one at random; were told the connection had failed; were told to connect to the network manually using the supplied credentials; found that we were already connected to the network; discovered that we could access the internet (Yay!); went back to the app which then told us everything had failed and that we needed to try again before booting us off its network. We tried again but the app couldn't connect to the network it was already connected to, then it told us, "Something came up" and the app restarted. Six attempts and 40 minutes later, everything worked and the device saved our new credentials and restarted. Then it crashed, lost all our settings and we tried hard not to punt the thing out of the window.

> "Despite the horrendous configuration issues, it did actually connect to the internet via 4G"

With such a dumpster fire of an app we accessed the firmware via our phone's web browser and quickly wished we hadn't. The firmware is excruciatingly slow to load any page and the layout is not mobile friendly. We crawled through some menus before being notified, "Device not found" and it crashed again. Accessing everything via a desktop PC marginally improved speed and reliability but configuration is still very painful. We're not missing much, though. Features are standard for any router except these all have 'A.I.' prefixes. There's also a failover setting to switch between wired and wireless if one of the connections dies.

Despite the horrendous configuration issues, it did actually connect to the internet via 4G (and also its Ethernet ports). Just note, it only supports a full-size SIM card so you may need an adapter. We took the opportunity to run a 4G Speedtest and achieved 20Mbps both down and up which matched our phone and its (third-party) Telstra-based MVNO provider's limits. It theoretically handles 150Mbps downloads but, in reality, everything will depend upon the strength of your local signal and network congestion.

In our standard, large-file-downloading Wi-Fi tests it scored 237Mbps up close, 220Mbps two rooms away and 4.7Mbps 25m away at the bottom of the garden. Basically, it's slow, but it certainly has much better range than last-gen rivals.

At $300 it's not cheap but if your desperation for Wi-Fi-6-grade range on a 4G router outweighs all other performance and reliability concerns, it might be worth buying.

Sadly, it's another half-baked product from D-Link.
Nick Ross

★☆☆☆☆

WIFI ROUTER

Fritz!Box 4060

Ultra fast Wi-Fi 6 connectivity and a built in DECT phone base station make for a unique router.

■ $389 | www.avm.de

■ Wi-Fi: 802.11ax6000 WiFi 6; WAN: 1x 2.5GbE port; LAN: 3x 1GbE ports; DECT: Supports 6x handsets; Management: Web, App; Warranty: 2 year local, 5 year manufacturer; Dimensions: 81 x 210 x 170mm

The Fritz!Box 4060 is aimed at higher end home users, or small business use, and certainly isn't on the bargain end of the price range. But for those who need its particular combination of features, the router is decent value for money.

The Fritz!Box 4060 is equipped with performance focused tri-band Wi-Fi 6 for wireless connectivity, while around the back it has a 2.5GbE WAN port, three gigabit LAN ports, and USB 3.0. The stand out here is the 2.5GbE WAN port – though Gigabit or faster internet is a lot easier to come by in Europe where the Fritz Box originates, so here in Australia the 2.5GbE WAN port feels a bit wasted. It's a shame the 4060 doesn't include switchable WAN/LAN ports, as a 2.5GbE LAN connection would pair well with a NAS. The USB 3.0 connection is much appreciated, and can be used to add in external storage, or connect USB devices such as a printer or 4G modem.

The Wi-Fi has 2400 Mbit/s throughput on each of the two 5GHz bands, and 1,200 Mbit/s on 2.4GHz. It can link to other Fritz! network devices, and create a wider mesh network – though the compatible nodes are quite expensive compared to the multipacks from some of the competition. Exact wireless performance will depend on your devices and environment, but using Intel AX201 2x2 Wi-Fi we had no issue hitting 802 Mbit/s (of a possible 1,200 Mbit/s for this device), and a great 143 Mbit/s at 10m range through multiple walls. Higher peak speeds would need a 4x4 Wi-Fi device on the client side, as the 4060 does not support 160MHz channels.

> "The Wi-Fi has 2400 Mbit/s throughput on each of the two 5GHz bands, and 1,200 Mbit/s on 2.4GHz"

The 4060 also includes a DECT phone base station, and while Fritz branded handsets are not sold locally, you can connect up to six compatible DECT cordless phones. The 4060 can have five answering machines, act as a fax machine if needed, as well as provide a comprehensive range of phone functionality such as call diversion and blocking. Using the Fritz App Fon, you can also link your smartphone to the 4060 over Wi-Fi, and use it to make landline calls using your configured numbers. Your phone also still works normally with your existing number, so is ideal for those who want to handle work calls while keeping their mobile number private.

The Fritz!Box 4060 can be controlled via the WLAN Fritz App, and there are other apps for accessing functionality such files on attached USB storage. Setup is quite straightforward, and the Fritz OS used on the 4060 has interesting features such as inbuilt power monitoring. There are also a lot of handy guides and information in the online knowledgebase. The Fritz!Box 4060 supports a range of Fritz Smart home options such as lights, switches and temperature control, but limited local availability makes it an overly expensive option.

The Fritz!Box 4060 has a two year local warranty, backed up by a further three years thanks to the five year international warranty from the manufacturer.

The Fritz!Box 4060 offers great value for those who can make use of its unique combination of features.

Lindsay Handmer

★★★★☆

KEYBOARD

Nzxt Function

Typing into the peripheral mainframe.

■ $159 | nzxt.com

If compact peripherals appeal to you then this MiniTKL form should be right up your street. A standard TKL board is usually compact, but Nzxt's MiniTKL format fits those same features into an even smaller shell. It essentially gets rid of the empty spacing around the TKL board and compresses all the keys together. It's not quite as small as some 60 percent boards, but is noticeably different from regular TKL keyboards.

There are no sharp unusual shapes or gamer-inspired designs here, but that's not a bad thing. Although this keyboard reaches out to the gaming market, it could easily fit into an office-based or productivity environment. The minimal design could be viewed as boring but with the per-key RGB backlighting, it's easy to fit into any setting. Unfortunately, this lighting isn't the brightest, but does disperse evenly throughout the board.

To the left side of the keyboard, there are media controls that are sometimes missing on compact boards. These include a rubberised volume wheel, mute, Windows lock button, and keyboard brightness cycle button. Ergonomically, it makes sense to have these on the left-hand side as, more than likely, your right hand will be using the mouse – though left-handed mouse users may not agree.

Underneath, there are two adjustable levels of kickstands to ensure a comfortable angle for typing. One thing that's missing from this MiniTKL board is the wrist rest, so you'll need to roll your own. The other two keyboards in the lineup come with wrist rests, albeit they are more expensive, but it's a shame one was not offered on this more compact version.

> "It's a well-made keyboard, but there are better alternatives on the market."

What about the actual keys on this Nzxt Function? Well, the caps themselves aren't too impressive. Out of the box, they're ABS, which feel cheap and are a nightmare for fingerprints. Using Nzxt's BLD program, you can opt for PBT caps, but these come at a higher price. The switches underneath are more impressive and are hot-swappable with a key tool that's included if you want to customise this further. Gateron red switches come pre-installed on this board and require little pressure to type on. For long durations of typing, it's a comfortable switch to use without too much audible feedback. Yet, as this is a gamer-focused keyboard, more tactile feedback and louder switches would perhaps be more suitable. The upside is that, being a hot-swappable keyboard, you can change the keys and switches to suit your personal tastes.

Although it's a well-made keyboard, there are better alternatives on the market for a similar price that don't necessarily need to be customised. We'd recommend upgrading to the PBT caps as these are much better than the ABS ones, but you can't help but feel they should come as standard. This MiniTKL variant is a great looking board, but it can feel cramped after long durations.

If you're after a productivity board or one for long periods of gaming, we'd recommend the larger boards with a wrist rest. The Function isn't a bad board and is certainly a decent first attempt at cracking the keyboard market, it just requires a fair amount of customisation to get it to a reasonable level.

Easy customisation, removable cable and nice ergonomic media buttons.

Sam Lewis

★★★½☆

MOUSE

Nzxt Lift

Clicking into the peripheral mainframe.

■ $69 | nzxt.com

At first glance, the mouse is in keeping with the design of the Function keyboard (opposite page). Finished in a matte material, it could pass in a more conventional office setting. Though an ambidextrous design, it still favours right-handed users, as there are two programmable side buttons on the left side for right-handed users' thumbs. One thing to mention here is that the mouse has quite a low profile and there isn't much room to rest your thumb on the side of the mouse without hitting these buttons. It's unlikely that you'll accidentally actuate them, but for comfort purposes, it's not ideal.

On the other hand, the mouse is generally a comfortable place to rest your hand, thanks to its matte plastic finish. Our review sample is the standard white version, though the Lift also comes in a black matte design. Through Nzxt's website, you can customise the accent colour on the mouse to add a splash of character to the design, with a choice of blue, cyan, purple, red, or yellow to spice things up. If you opt for the Nzxt combo of the Function and Lift, you could create an interesting setup theme with the customisability on offer.

To help match your theme, the Lift has a subtle RGB underglow that is controllable in the Nzxt CAM software. There are six available buttons with mappable availability within the program. We've already mentioned the two buttons on the side, but you also get a DPI/profile button, which sits below the scroll wheel. This wheel feels great to use, as it's covered in a dotted rubber that grips well and gives you plenty of control over scrolling.

> "It's in the performance where the Lift is really elevated to a higher plane."

Press the DPI/profile button to cycle through levels of 400, 900, 1800, and 3600dpi. You get visual confirmation of which DPI you have selected via the RGB under-glow on the lift. This is also configurable in increments of 100dpi and you can pick a custom colour to add to these settings over on the CAM software. Long-pressing this button lets you choose between four different profiles that can be adjusted in the software.

On the whole, the mouse has some nice design cues – the matte finish isn't slippery and there's no rubberised grip on this peripheral. It's a lightweight mouse too, which could be one of its downfalls – it seems Nzxt has favoured performance over build quality here as the mouse has some plastic creaking and feels a little on the cheap side.

But it's in the performance where the Lift is really elevated to a higher plane. There are three PTFE feet that all help the device glide gracefully over your desktop. In terms of the sensor, it's a popular optical PixArt 3389. It feels responsive, snappy, and accurate – exactly what you'd want from a mouse but a pleasant surprise at this price. As for the switches for the left and right clicks, the Lift uses Omron mechanical switches. They are quick to actuate and have a tactile spring to them, which makes it comfortable for use for both work and gaming.

For a mouse, the Nzxt Lift isn't exactly groundbreaking, nor does it offer anything new that isn't already on the market, yet this is a solid first attempt by the brand.

Zippy performance, lightweight and good value for money.

Sam Lewis

★★★½☆

PC AUDIO

RAZER LEVIATHAN V2

A highly impressive all-rounder PC audio solution.

■ $399 | www.razer.com

The Razer Leviathan V2 brings a much needed refresh with one of the best computer audio experiences you're going to find right now, and it's not even really close. And while not exactly cheap, the Leviathan V2 offers an incredible soundscape at a reasonable price point, easily making it one of the best computer speakers you can buy right now. It's not without its faults though, and the loss of 3.5mm and optical input pretty much consigns the Leviathan V2 to your PC for good, though it does have Bluetooth connectivity as well so you still have some flexibility.

The THX Spatial Audio is a welcome feature; this goes beyond basic stereo to create a much more surround sound-like experience. The bass response from both the subwoofer and the soundbar itself is impressive. Thanks to the array of drivers on both the soundbar and subwoofer, the soundscape produced by the Leviathan V2 is honestly one of the best audio experiences you're going to find anywhere close to this price range. Gaming, blasting music, watching new Netflix movies between gaming sessions, whatever. It's going to sound amazing.

> "Honestly one of the best audio experiences you're going to find anywhere close to this price range."

The two passive radiators on the soundbar definitely improves the low register performance of the Leviathan V2 over its predecessor by digging deep into the 45Hz territory, down from the 180Hz of the Leviathan V1. The full range drivers and tweeters also easily fill the room, and a switch in the Synapse settings can redirect the sound to the centre channel, making sure that you are getting the fullest audio experience when sitting at your desk.

The Razer Leviathan V2 soundbar-subwoofer combo boasts some of the best computer audio we've heard outside of a studio setting.

John Loeffler

★★★★½

GAMING HEADSET

JBL QUANTUM 610 WIRELESS HEADSET

Tremendous bang-for-buck wireless headset.

■ $229 | www.jbl.com.au

The 610 is a headset with just enough gaming styling without being ridiculous. The headband and cans are generously padded, arms extend with a solid and satisfying ratchet sound, attachment cables are all nicely braided, and the pivot point that allow the cans to fold flat so they sit nicely if they're hanging around your neck feels robust and unlikely to be rage-broken. The power switch is on the right can, while the boom mic, individual volume/mic controls plus USB-C and 3.5mm ports are crammed over on the left. It's a good looking and functional headset. And, thankfully, super comfortable on the noggin as well. The headset connects via a 2.4G wireless USB dongle for your PC, PS4 and Ps5 and 3.5mm jack for anything else.

Running the key numbers, we see massive 50mm drivers, a 20Hz-20kHz response, and a 32 ohm impedance. And while yep, that's all pretty standard stuff when it comes to gaming headphones these days, the 610s manage to make magic from the mundane. There's a comfortable warmth to the sound, and punch throughout without the bass, mids and trebles stepping on each others toes.

If you want to get a little more out of the 610s, you're going to want to install the JBL QuantumEngine; don't worry, there's no sign-ups or log-ins necessary unlike some of the other players in the space. It's where you go to configure the all important (most important?) RGB lighting options. Here is also where spatial settings such as QuantumSurround and DTS2.0 plus EQ presets can be toggled and fine tuned to taste.

The soundscape and spatial definition QuantumSurround achieves inside small cans is genuinely impressive!

JBL boasts a battery life of 40 hours. While we didn't get the stopwatch out and time this, there were few times during our review that had us reaching for the USB charge cable. And even then, you can continue to use the headset tethered while the recharging.

The Quantum 610 Wireless is a solid, comfortable and great sounding gaming wireless headset without the need to sell a kidney.

Troy Coleman

★★★★½

Windows | FREE | www.cybertronsoft.com

PRIVACY ERASER FREE 5.23

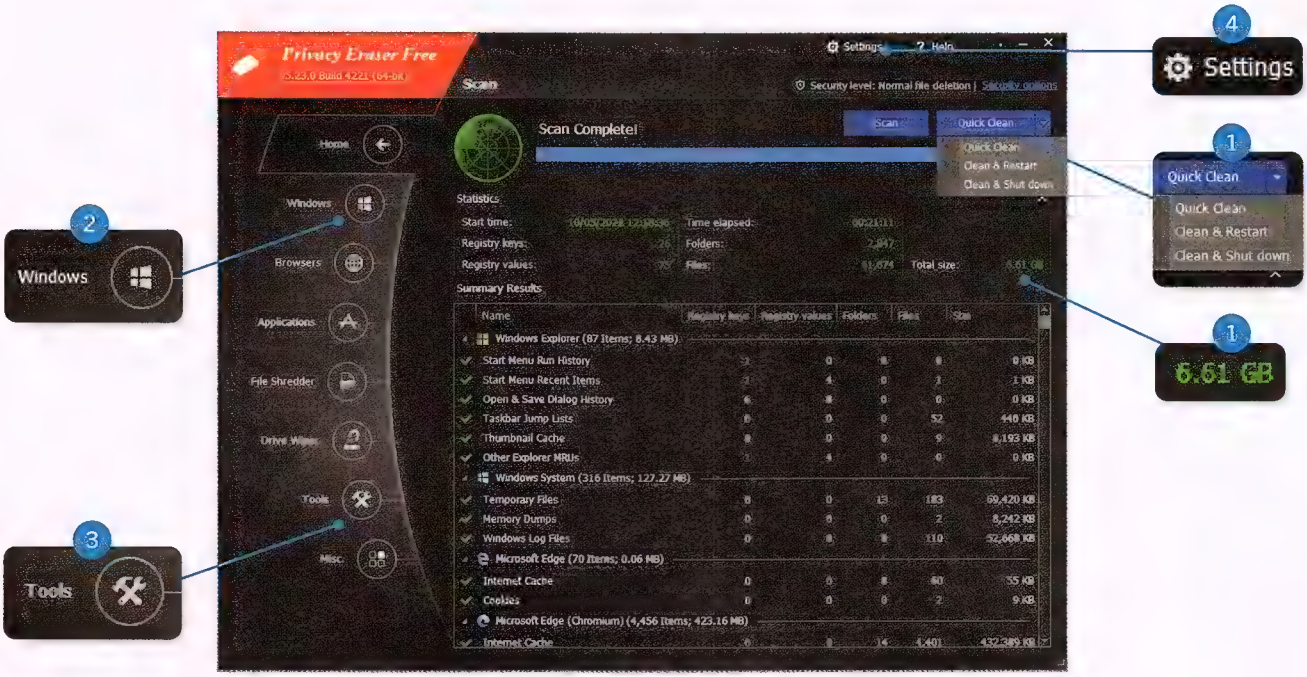
FastStone Image Viewer is one of the most popular free programs for browsing photos stored on your computer.

Like CCleaner, but without that program's oft-reported problems, Privacy Eraser frees up space on your hard drive and protects your privacy by deleting details of your Windows and web activities. At first, we were slightly sceptical of its generic name and its interface's similarity to dubious IObit products. We also assumed that many features would be restricted to the Pro version, which costs US$19.95 a year. Happily, our fears were unfounded and Privacy Eraser Free lacks only three options from the paid-for version: automatic updates, technical support and secure overwriting of deleted data.

The program is very easy to use: simply click the big Scan button on the home screen to detect junk files on your PC and discover how much space you can recover by removing them. This takes a while the first time you do it, but you can speed up future scans and tell Privacy Eraser to ignore data you want to keep by clicking the Windows and Browsers tabs on the left. Untick options such as Start Menu Recent Items and Typed URLs to exclude them. There's also an Applications tab, which identifies software installed on your PC and lets you decide which tools to clean. Once the scan is complete, click Quick Clean to delete the detected junk, 'Clean & Restart' to purge all leftover traces or 'Clean & Shut down'.

New features in version 5.23 include improved scanning of cookies you want to keep, so you're not logged out of websites, and cleaning of Windows Event logs (which store details of system operations) and network-usage data. Additionally, the program's uninstaller, which you'll find on the Tools tab, has been improved to make it faster at removing unwanted software. Other useful tools include a File Shredder and a Drive Wiper, though – as mentioned – the free version only overwrites data once, and further 'passes' require you to upgrade.

> "Click the big Scan button on the home screen to detect junk files on your PC and discover how much space you can recover by removing them."

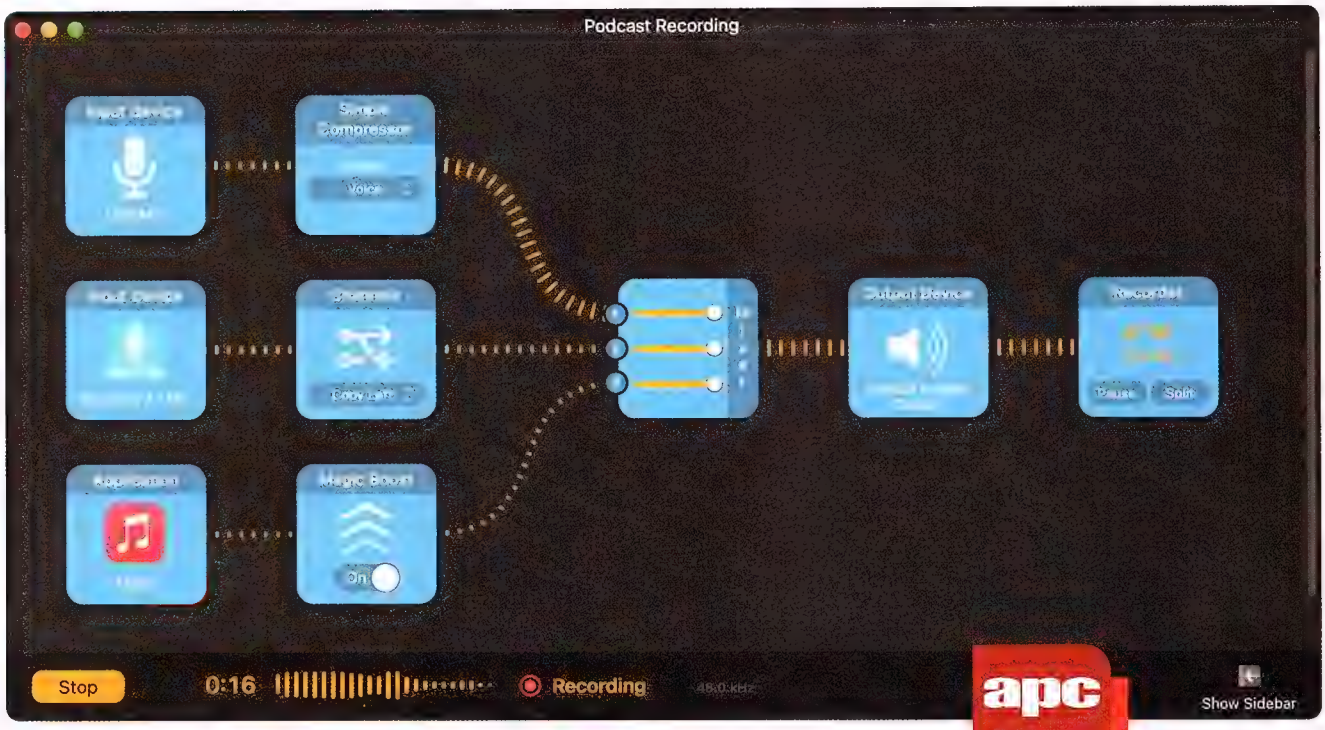


1 Once Privacy Eraser has scanned your PC for junk, it tells you how many files it's found and how much space you'll save by deleting them – 6.6GB in our case. You can then choose a clean-up option from the menu in the top-right corner.

2 On the Windows tab, you can specify which elements of your operating system to clean, including File Explorer data, event logs and the registry. Similarly, the Browsers tab lets you decide which junk to delete from all your web browsers.

3 Click the Tools tab to access some useful extra features, including a startup manager that lets you stop software running automatically and an uninstaller for removing unwanted programs. You can also delete system restore points.

4 Click Settings to tweak how Privacy Eraser works and looks. Options include preventing it from running on start-up, excluding certain folders from its scans, scheduling regular clean-ups and customising its appearance with different themes.



macOS 10.14 or later | US$77 | rogueamoeba.com

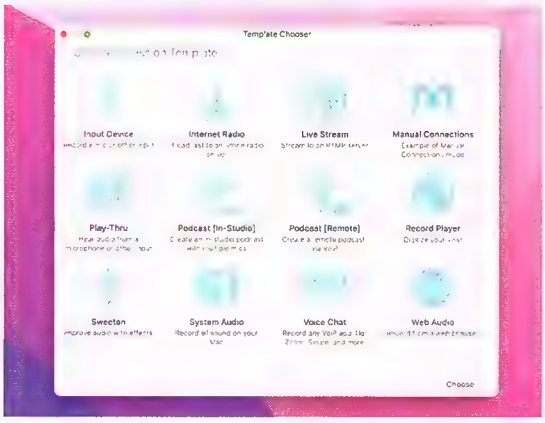
AUDIO HIJACK 4

Capture any audio streams on your Mac

Above: Drag and configure blocks to hijack, process and record sound from any application and microphones on your Mac.

Audio Hijack is a clever app that can intercept and record any audio playing on your Mac, be it from a connected microphone, a Skype call, a video playing in Safari or anywhere else. A simple use for it would be to record a conference call but you could also record a multi-mic podcast, or digitise and clean up your vinyl collection. It records directly to a file and doesn't have any editing tools though the developer makes Fission, which does, and the two can be bought together at a discount.

You start with a Session, and numerous templates are provided for common tasks. Your Grid contains Blocks which represent inputs, outputs and processors but it's all friendly to use with a list of available blocks containing descriptions, and shouldn't deter even inexperienced users. Drag an input block and choose its input – Safari, your Mac's system sound or a microphone, for example. Then drag a Recorder or broadcast block between the input and output, and they are automatically linked. Each block can be customised to change, for example, recording quality, time limits for recording or which application you want to hijack. If you drag more blocks in they can be easily connected to each other, so you might for example have two record modules capturing an uncompressed and an MP3 version of the same music stream. Or run three mic inputs through three recorders to capture three separate audio files, all in sync.



You start with a session – and this can be picked from a variety of templates – and you then add your input blocks.

On top of this there are a number of built-in effects blocks including EQ, denoising, 'magic boost' and even a mixer module for submixing different sources inside a session, giving you more control over music and voice levels in a podcast perhaps, before outputting to a single audio file. Audio Hijack can also use any Audio Units plug-ins installed on your Mac, again by simply dragging them between blocks to insert them. There's also a scheduler which can wake your Mac and start recording at specific times, and for more adventurous users a script section where you can build Automator-style actions for timed recordings.

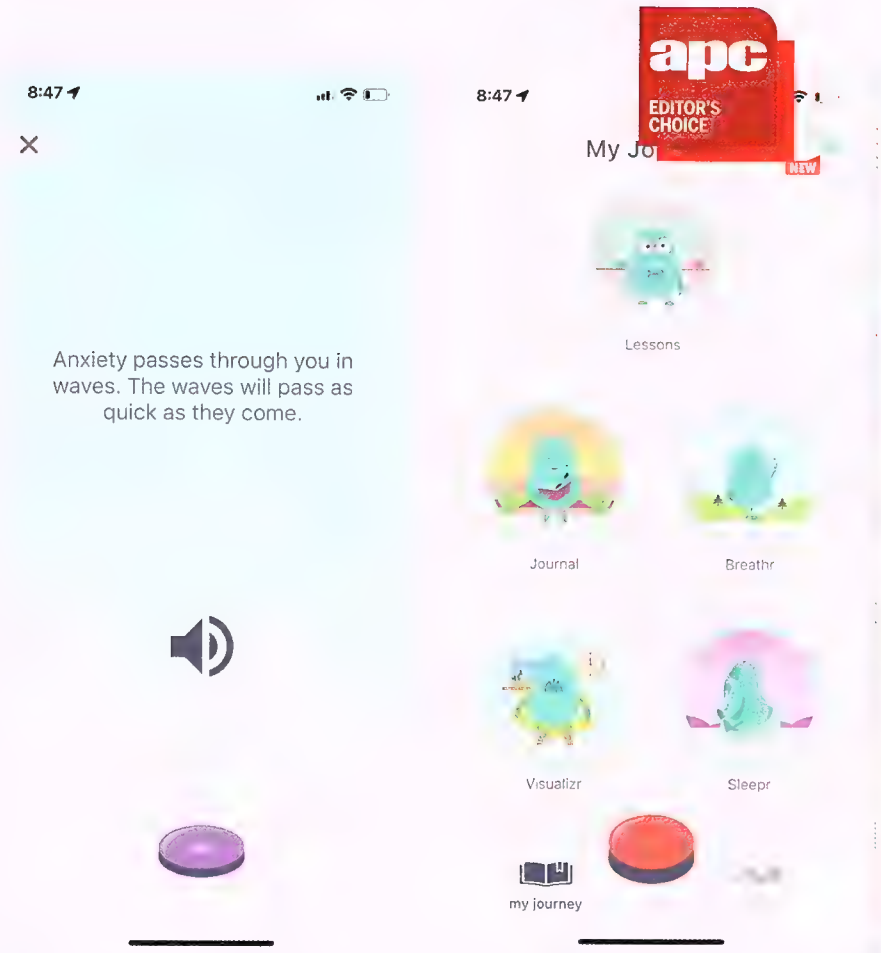
Many of the features have been enhanced since version 3, and some are entirely new. Overall, the app has a more slick and modern feel, with more presets and options but retaining a friendly approach. It makes audio routing and capture very easy to understand thanks to its grid system and clear workflow, while offering access to audio streams from anywhere in a way that would actually be very fiddly to do using most pro audio software.

Whether you're recording calls, ripping your music collection or making a podcast, Audio Hijack can do it all and won't blind you with science.

The best app on the block for audio capture on the Mac. Slick, powerful and effective for all sorts of uses.

Hollin Jones

★★★★★



iOS/Android | Free with Optional Subscription

ELEVATE

Train the Brain, Avoid the Drain.

Ever since "Brain Training" launched on the Nintendo DS over a decade ago, I've been a huge fan of the concept. While the scientific consensus on whether these sort of rapid "training" elements work is out, the app doesn't claim that you will necessarily be smarter at the end of a session.

Instead, much of what the app claims to assist with is improving your cognition on completing everyday tasks, such as basic mathematics, reading, writing, and vocabulary. Instead of teaching you algebra, for example, it might be easier to compare prices or quickly split a bill, or quickly read a section of text and understand it without a second or third re-read.

There's also a great performance tracking system that shows your improvements over time, and over the week I tried it, I did find it a little easier to complete the maths questions (which have never been a strong suit for me) and I enjoyed the reading comprehension, which I felt had been slowing down as I rapidly approached 40.

Each day, things get incrementally more difficult, but not in a way you would especially notice. Additionally, when you do make mistakes, the app alerts you to them and why, then stealthily repeats them in the same session or a few days later to see if you've learned.

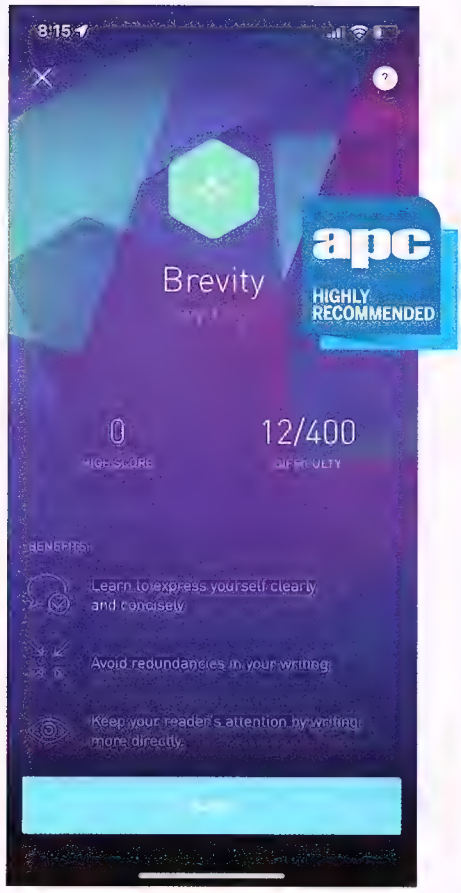
None of the "games" overstay their welcome – most are completed in less than a minute, and are varied enough that when they do eventually repeat, you don't really notice because the content is different.

The app is slick and easy to use, and I enjoyed it enough that I sent it to a few friends and my wife after I initially tried it, and everyone agreed it was fun and moreish. That said, like most apps nowadays, there is a subscription to unlock the full program (five games a day, all 40 types, custom workouts, exclusive content) which ends up at about $5 a month if paid for in advance, or a whopping $15/month if not.

A great app for a morning brain jolt, but the cost (Netflix is cheaper) might be a bit of a barrier for most.

James Pinnell

★★★★½



iOS/Android | Free with Optional Subscription

ROOTD

Calm down.

I must give this app points for its name – Rootd – which cleverly details both how you feel when you are suffering from an anxiety induced panic attack, and what you need to do in order to move through it. Its developers are sufferers of anxiety and designed the app in order to use existing, proven, techniques to recover.

The app features a panic button, which when pushed immediately begins effective guided breathing exercises. When you aren't in an emergency, there are lessons for managing anxiety, avoiding triggers for attacks, and attempting to understand the root (heh) cause.

While I will give this app points for its simplicity and core feature set, I must note it has a very poor design. It desperately needs some time invested on its UI and graphics, as well as its stability. Especially considering they are asking for $7 a month for the privilege.

James Pinnell

★★★★☆

Linux | $Various | www.fedoraproject.org

FEDORA 36

Mayank Sharma calls the latest Fedora release just as boring as its predecessors. But is that a bad thing?

Generally speaking, it's difficult to become excited at Fedora releases. And that's a good thing. Unlike its often-fidgety peers, the Fedora developers quietly keep cranking out releases. Usually there's hardly any noticeable difference, and most of it can be attributed to the Gnome desktop environment. The majority of changes in Fedora usually happen behind the scenes, and manifest themselves in the nooks and crannies of the userland in very subtle, but important ways.

And the developers don't intend to change this winning formula with the Fedora 36 release. The most obvious evolutionary change in the distro is the inclusion of the Gnome 42 desktop environment, which is also part of the Ubuntu 22.04 release. However, unlike Ubuntu's tweaked rendition, Fedora 36 ships with a more or less pristine Gnome 42 release.

The highlight of Gnome's latest version is a system-wide dark theme, with wallpapers for both dark and light themes, and tweaks to the folder icon theme to bring their appearance in line with the desktop.

The new desktop also brings an improved cache of programs, many of which have been ported to GTK4. The move to GTK4, thanks to all the behind-the-scenes work, will add a spring to the step of these applications, along with subtle changes to make them appear more modern. The most noticeable change is the new interactive screenshot tool that can now also record screencasts of the screen or a part of it (in the WebM format), in addition to taking static screenshots. The release also brings a replacement to the Gedit new text editor. The new one's simply called Text Editor, and in addition to the improved UI, the GTK4-powered tool also includes useful new features, such as auto-save.

A Fedora release is made up of several distros. Besides the Fedora Workstation release that's designed for desktop users, there's also Fedora Server, and Fedora IoT designed for their namesake environments. These will soon be joined by Fedora CoreOS, for cloud computing, and Fedora Silverblue, which delivers an immutable desktop ideal for containerised-environments. While Workstation defaults to Gnome, the project has a few official spins for desktop environments. A notable change in one of these, the LXQt spin, is the inclusion of the 1.0 release of the lightweight desktop.

Looking under the covers, one of the most relevant changes for desktop users, especially the ones with Nvidia graphics, is that the release will use the Wayland server even on installations that use the Nvidia driver.

Elsewhere, the rpm-ostree Fedora 36 variants, such as Fedora Silverblue, will now have the /var directory on a separate subvolume to help users maintain snapshots of dynamic data separate from the system snapshots. In the same vein, the RPM database has moved from /usr to the /var directory, which again will simplify snapshots and rollbacks, especially for admins. This is being touted as one of those changes that come into being in Fedora, and will eventually get replicated in Red Hat Enterprise Linux, after it gets a shakedown.

All things considered, Fedora 36 is like any Fedora release: pleasingly rock-solid and stable. In fact, we've been tinkering with the code-complete Beta release, which came out after missing a couple of deadlines (another testament to Fedora's insistence on stability over anything else). We didn't encounter any bugs during our testing on real and physical hardware, and are confident the Beta bears a very strong resemblance to the final release, which at time of writing is currently scheduled for release before the end of April.

As good as any release for new users to get into Fedora, and a must upgrade release for existing users.

Mayank Sharma

★★★★☆

Activities
Apr 2 16:06
Fedora 36 is the latest Linux distribution to offer users a dark mode interface that can be switched on easily with a single click.
Selection
Screen
Window

apc HIGHLY RECOMMENDED

$1,500 HOME & OFFICE PCs

The best budget bang for buck desktop PCs, as Chris Szewczyk rounds up some great examples of how far $1,500 goes.

The global economy is looking very shaky, and probably will be for some time to come. In a time of steep inflation, with household budgets taking a hammering, finding bang for your buck is more important than ever.

During the pandemic, many of you would have come to realise that a smartphone or tablet just can't perform the kinds of tasks that a PC can. Even a laptop might not be up to the task. Is the screen too small? Is it noisy? Is the keyboard uncomfortable to use? Laptops and desktops, while fundamentally similar, are really rather different devices. The humble PC is here to stay.

With that in mind, we've gathered a range of PC systems that offer real value for money. Whether you need a system for working from home, a gaming rig, or something for the bedroom, we've got some awesome systems that deliver not just value, but smart performance too.

It's easy to get carried away by sales people saying you should buy this PC or include this graphics card or add that component. Gaming is an exception, but a 2022 PC, even a budget one can do just about everything you ask of it. Multitasking? Media consumption? Productivity? Heck, what about just playing TikTok or encoding some little videos or tweaking some photos for Instagram? A powerful PC is overkill for a huge chunk of the market. Don't get sucked into spending big money on capabilities you will rarely, if ever take advantage of.

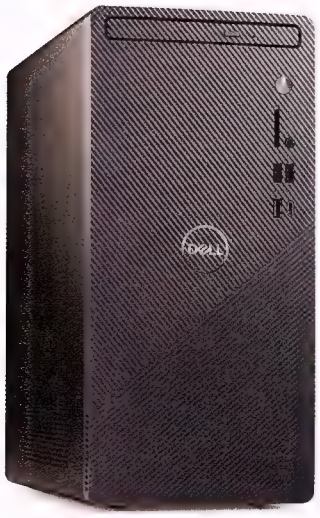
There are a multitude of reasons to buy a PC. The pandemic means that workers require a capable system in order to keep on top of their workflows and stay in touch with colleagues. But then there's other reasons too. How about a PC for the kids' bedroom? A compact system for the lounge room or to host a surveillance system? Perhaps the very idea of a PC is daunting, let's say for those from older generations who treat tech with trepidation? Maybe you just want something to plug in and turn on with reliable after sales service?

> "Don't get sucked into spending big money on capabilities you will rarely, if ever, take advantage of."

Our selection of systems cost no more than $1,500. It's a good amount to spend on a PC. You can spend a lot more, but diminishing returns becomes a factor once you get to $2,000 or more. Of course, you may need to add your peripherals on top of that, including a monitor. But we've got an affordable AIO that won't need it.

All of these systems have their strengths and weaknesses. Which one is right for you will depend on what you need from your PC. Do you want to game? Check out the Mwave system. Do you want something truly tiny? The Leader NUC might be for you. Do you want something you can upgrade with ease? Check out the PCCG system. If you want something truly plug and play, the HP AIO is where it's at. Then there's the Dell. It's a well balanced and compact little unit. There's no such thing as a perfect PC, but if your budget is $1,500, there's something here for everyone.

■ Intel Core i5-12400; Intel UHD 730 IGP; 1x16GB DDR4-3200; 512GB Micron NVMe SSD; DVD RW drive; WiFi 6; Windows 11 Home.



DELL INSPIRON COMPACT DESKTOP

A capable little system at the right price.

■ $1,339 | www.dell.com.au

If a work from home user is looking to buy a new PC, the chances are they will look at a Dell, and why not. It's a big company with a reputation for good after sales support and generally well made and well-appointed machines.

The Dell Inspiron Compact Desktop is a relatively slim mATX-sized machine. It looks good and it comes with a DVD burner. Other key specs include an excellent Core i5-12400 processor, 16GB of RAM and a decent 512GB SSD. Dell includes a wireless keyboard and mouse for a little bit of extra value.

Dell systems are known for their bespoke hardware, though in this case, you can add additional SATA drives, swap out the NVMe SSD or install a 16x expansion card, though with a 180W PSU, it doesn't include any PCIe power connectors, so you'd need to put a sub 75W GPU in there if you want extra graphics grunt.

The little Dell performs well in the benchmarks, but it cannot match the much better i7-12700 of the PCCG system. As a general-purpose work from home PC it does a good job, staying relatively quiet. It's got a good set of ports and Wi-Fi 6 is a welcome inclusion.

> "The little Dell performs well in the benchmarks."

The Dell Inspiron Compact Desktop can often be found for hundreds of dollars less that its $1,339 sticker price. At its full price, we'd spend the extra $160 for the higher spec and upgradeability of the PCCG system, but at closer to $1,000, this little Dell goes from being an adequate machine, to an excellent one.

This little Dell offers a solid spec for the money, but do keep an eye out for large discounts, which changes it from good to great value.

★★★½☆

■ 23.8in FHD touch display; AMD Ryzen 5 4600H; AMD Radeon integrated graphics; 8GB DDR4-3200 RAM; 512GB NVMe SSD; Gigabit LAN, Wi-Fi 5, 1x HDMI 1.4, 2x mini-DP 1.2; 120W AC power adapter; Windows 11 Home.

HP PAVILION 24 ALL-IN ONE

If you buy a PC, you'll need a screen to go with it. Voila!

■ $1,499 | www.hp.com.au

If you buy any one of the other systems in our roundup, you have to source a monitor too. That's the beauty of an AIO. You can think of The HP Pavilion 24 All in One as a laptop with a 24in immovable screen.

The 23.8in FHD IPS screen features touch functionality and there's no doubt it's the main selling point of this PC. It has a HDMI input too so it can just as easily function as a screen for a gaming console or a set top box. Sounds handy for the kids room?

> "Presents a totally different value proposition to the other systems"

The Pavilion 24 AIO can't match the desktop systems in terms of spec, but you wouldn't expect it to at $1,499. It includes an AMD Ryzen 5 4600H processor with integrated graphics and 8GB of RAM. That CPU is a 6C/12T model so it actually has a good amount of multithreading performance compared to the Leader NUC. It falls behind in single threaded performance, but not by a lot and in the PC Mark tests, it draws close to the more powerful i5-12400 equipped Dell. Its main weakness is its 8GB of RAM, though HP has an option for 16GB, and it's well worth spending the extra money for it.

As a home system, and one that comes with a monitor included, it presents a totally different value proposition to the other systems here. As a bedroom PC or a basic office productivity machine, it works well, the fact that it doubles up as a secondary monitor with a touch screen is a bonus. If you already have a monitor though, you'll get better performance from a standalone desktop.

The HP 24 isn't the most powerful PC around, but its IPS touch screen adds a lot of extra value at this price

★★★★☆

■ Intel Core i5 1115G7; Intel Iris Xe graphics; 8GB RAM; 500GB NVMe SSD; Intel 2.5G LAN, WiFi 6, 1x HDMI 1.4, 2x mini-DP 1.2; 90W AC power adapter; Windows 11 Professional.

LEADER SN14-I5 MINI PC

A tiny PC with some big selling points.

■ $1,399 |]www.leadersystems.com.au

Leader Computers is a well-known Australian-owned distributor and system manufacturer. Its SN14-i5 is a NUC form factor mini PC that's surprisingly capable in spite of its diminutive size. Leader's systems are available from many retailers all around Australia.

The SN14-i5 includes an 11th Gen i5 Tiger Lake 4C/8T processor, 8GB of RAM and a 500GB NVME SSD. Leader will certainly offer a 16GB RAM option as it does for its outgoing 10th Gen systems. At $1,399 it might seem overpriced for a unit with that spec, but that cost can be justified.

Its triple display support, quality connectivity options and low power consumption are notable features and mean it can function as a very good general-purpose office machine, but it might be the three-year Australia wide onsite warranty that appeals to a WFH user, especially one that isn't that tech savvy. You'll find NUCs with a similar spec for cheaper, but that kind of after-sale support is a feature unto itself, and the premium price will be money well spent for the right user. It comes with Windows 11 Professional too. A good value add.

> "It comes with Windows 11 Professional too. A good value add."

It doesn't excel in the benchmark wars, but for essential productivity tasks, media consumption or general internet usage the NUC form factor has a lot of appeal. It really is impressive to get the performance of a flagship PC from just a couple of years ago in a system you can fit in the palm of your hand. This NUC is a solid choice for a user that's happy to pay extra for after-sale peace of mind.

This classy little NUC isn't for everyone, but its key strengths give it a strong niche appeal.

★★★★☆

■ AMD Ryzen 5 5600X; Asus Radeon RX 6600 GPU; 2x8GB DDR4-3600 C17; Crucial P2 1TB PCIe 4.0 NVMe SSD; Corsair CX-M 650W 80Plus Bronze PSU; Cooler Master Masterbox TD300 Case; Windows 11 Home.

MWAVE RESPAWN NINJA RAPID GAMING PC

Yes, $1,500 can get you a decent gaming PC.

■ $1,499 www.mwave.com.au

It's not easy to buy a genuine gaming desktop for $1,500, well, at least one that's not as weak as a wet paper bag. Mwave's Respawn Ninja Rapid gaming PC is a very well spec'd PC for the money. It includes a six core Ryzen 5600X CPU and Radeon RX 6600 graphics card. This means it's easily capable of playing any game at 1080p and more than a few at 1440p as well. Add a 1TB SSD for your game library and 2x8GB of DDR4-3600 and you've got a capable system for work or play.

It's very well built and packaged, with a full set of accessories and comes with a two-year RTB warranty. If you like RGB lighting, this is a great option, with four 12cm RGB fans all controlled via Asus' Aura Sync app

As the only gaming-oriented system in the roundup, of course it's easily the most powerful at gaming or tasks that can make use of the GPU, but it can do anything else you throw at it too. There's nothing stopping you from using this as a workhorse during the day, though the Intel 20-thread i7-12700 CPU of the PCCG system will get the nod over the AMD 12-thread 5600X in anything that can make use of CPU grunt.

"A clear winner though that's by virtue of its RX 6600 GPU."

As a gaming PC, the Mwave Ninja Rapid is a clear winner though that's by virtue of its RX 6600 GPU. You can always add a GPU to systems that support them for gaming grunt. But then if you wanted to do that, you probably wouldn't be buying a prebuilt PC.

Take the Mwave home, plug in your monitor and peripherals, run through the simple Windows setup steps and you'll have a competent 2022 gaming PC.

Mwave's $1,500 gaming PC will play all games at 1080p. It looks the part too.

★★★★½

■ Intel Core i7-12700; 2x8GB DDR4-3200 C16; 1TB PCIe 4.0 NVMe SSD; Phanteks 650W 80Plus Gold PSU; Phanteks Eclipse 300A Mesh Edition case; Windows 11 Home.

PCCG PRESTIGE CORE I7 HOME & OFFICE PC

A strong local brand takes on the likes of Dell and HP.

■ $1,499 | www.pccasegear.com

PC Case Gear is a name that's surely familiar to all of our readers. But the company doesn't just do components and gaming. It's branching out into the realm of home and office PCs and its $1,499 Prestige Core i7 Home and Office PC is a humdinger for the money.

It packs in a fast i7-12700, 16GB of DDR4-3200 memory and a 1TB NVME SSD. That alone is enough horsepower and capacity to function as a serious productivity PC. It's got a high quality 650W PSU, which means this is a PC that will happily accept a graphics card in the future, becoming a gaming PC.

"The PCCG Prestige comes with a two-year return to base warranty."

The PCCG Prestige has the most powerful CPU in the roundup, easily leading the pack in anything that's CPU reliant. It can't compete with GPU equipped systems in graphics capability but that's not what it's for. It's designed to handle heavy multi-tasking and complex workflows. The MSI motherboard at the heart of the system has a good solid set of USB ports and expansion options. It's got a spare NVMe slot and SATA ports, so you can add plenty of extra storage should you need it.

The PCCG Prestige comes with a two-year return to base warranty, paid for by PCCG, so apart from the slick after sales support of HP or Dell, there are few reasons left to choose a desktop from one of those companies, unless you can snare a real bargain.

$1,499 for a system with a 12700 CPU, 16GB of RAM and a 1TB SSD means you get a really smart system for the money. It's got grunt, upgradeability, and you could pop in a good spec GPU and you'd have a potent gaming system.

The PCCG Prestige shines with its smart choice of components, great value, RTB warranty and excellent upgrade potential.

★★★★½

CONCLUSION

BUYING A BUDGET DESKTOP 101.

So, there's a look at what $1,500 gets you these days. It's clear that there's no single solution for every use case. The form factor is the most obvious differentiating feature. We've got an AIO, a NUC and desktops – how's that for apples and oranges!

What kind of PC you go for strongly depends on what you want to use it for and what kind of experience you want from your PC. If you view your PC as just a means to an end and nothing more, then you'll probably be looking at something with a strong after-sales focus and a simple setup. Turn it on and you're away.

You'll notice that the benchmark results vary widely between the different systems. In the case of gaming, there's the Mwave system and then daylight. Apart from gaming, unless you're running tasks that require real grunt, like rendering or encoding, which benefit from the power of the PCCG's i7-12700, any of these machines will do typical office productivity and day to day tasks with ease. You can see it in the PCMark Essentials test, which measures a variety of common workloads.

Choosing a desktop system isn't easy, especially if you're not the most tech savvy user but now that you've got an idea of the different machines that are available, and what they're capable of, we hope your purchase decision will be a little easier.

"Apart from gaming, unless you're running tasks that require real grunt, like rendering or encoding, which benefit from the power of the PCCG's i7-12700, any of these machines will do typical office productivity and day to day tasks with ease."

$1,500 HOME & OFFICE PCS BENCHMARK RESULTS

		HP Pavilion 24 AIO	PCCG Prestige Core i7 Home & Office PC	Mwave Respawn Ninja Rapid Gaming PC	Dell Inspiron Compact Desktop	Leader SN14-i5 NUC
Handbrake Video Encoding	4K to 1080p FPS	28.4	58.4	43.3	40.1	25.1
Cinebench R23	Multi thread Score	8,043	16,746	11,467	11,516	5,520
	Single thread Score	1,169	1,765	1,510	1,581	1,225
3DMark Storage Benchmark	Score	1,559	3,382	1,511	2,043	1,003
PCMark 10	Overall	3,823	4,674	9,402	3,852	3,640
	Essentials	8,601	10,719	10,850	9,969	7,984
	Productivity	7,796	8,114	9,543	7,479	5,812
	Digital content creation	4,916	6,782	11,573	4,920	4,783
Temperature	Max CPU temp (°C)	75	88	63	77	86
	Max GPU temp (°C)	67	55	64	57	58
F1 2021	Min FPS	crash	16	90	10	16
	Avg FPS	crash	14	79	8	14

FEATURE

Ryzen again The resurrection of AMD

Five years ago, AMD nearly went to the wall. Now, it has the edge on Intel and Nvidia, and billions in the bank. Jeremy Laird investigates its dramatic resurgence.

Make a note of the date, 22nd February 2022. That was the day AMD's market capitalisation – essentially, its overall value as a company – surpassed Intel's for the first time. It was nothing less than a spectacular reversal in fortunes for a company that had been on the very brink just a few years earlier. Forget wondering whether AMD can even survive, it is now an entirely legitimate question to ask whether AMD can overturn Intel's dominance of the PC. Truly, AMD has become the pretender to Intel's throne.

Of course, stock prices don't tell you everything about a company's real-world proportions. Intel still has a 75 percent market share for PC processors and generates massively more revenue and profit than AMD. But the notion of AMD as the usurper of Intel's position as the predominant purveyor of PC processors and platform technology is now more plausible than ever.

How, exactly, did AMD turn it around? Now that's a question. As we'll see, a little bit of luck didn't hurt. But as the saying goes, you make your own luck and there's absolutely no denying the heightened competence and consistency with which AMD has been led since Lisa Su took over the company in 2014.

All told, AMD's recovery from near oblivion makes for a fascinating story of corporate and technological rejuvenation.

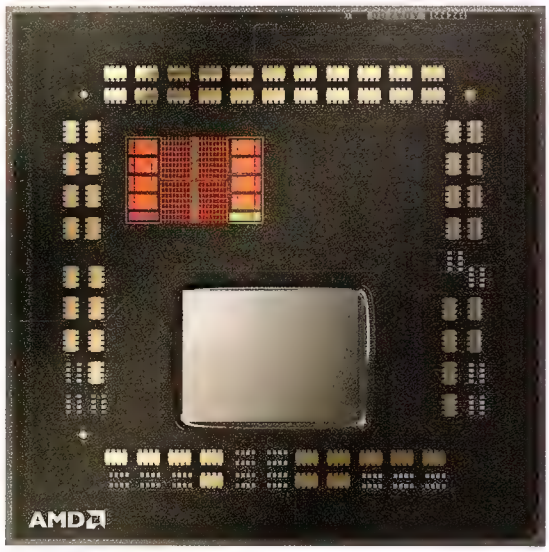
Undeniably intimate. Often symbiotic. And occasionally parasitic. Such has been AMD's relationship over the decades with its greatest rival, Intel. Truly these are two companies with a shared destiny. The story of AMD begins way back in 1969. Inevitably, Intel looms large right from the start. AMD was founded by eight former employees of Fairchild Semiconductor and headed up by none other than Jerry Sanders, former marketing boss of Fairchild and the leading figure in AMD's early years. It was only 12 months earlier that Robert Noyce and Gordon Moore also left Fairchild to set up... you guessed it, Intel.

Both companies set out to make an impact in the nascent integrated circuits business, otherwise known as computer chips. But from the start, they took different paths. Intel went heavy on the R&D to create its own designs, while AMD opted for the quicker and less expensive route to market by being a so-called second source supplier of microchips designed by Fairchild and National Semiconductor.

Second sourcing is all about securing reliable component supply and not depending on just one company. You can read how AMD went from a second source supplier of IBM-compatible CPUs to sharing full access to Intel's all-important x86 instruction set later in this article. But suffice to say, by the early 1980s, AMD was carving out a niche as the leading alternative to Intel in the PC processor market.

Intriguingly, AMD was much more competitive during this early period than the standard narrative of perennial underdog allows. The usual refrain around AMD's latter-day success with its current Zen-based CPUs involves the mighty K8 series, the architecture that underpinned the Athlon 64, as the only substantial example of AMD getting one over on its arch-nemesis. But the real story is much more complicated than that.

As early as 1984, AMD was manufacturing Intel's 286 processor as a second source supplier to IBM but achieving up to 20MHz clockspeeds whereas Intel's in-house chip topped out at 10MHz. The 386 era was something of a hiatus as AMD and Intel feuded over rights to the x86 ISA, but when AMD eventually managed to reverse engineer the Intel chip, just like the 286, AMD's take on 386 outclocked its Intel rival.



AMD's Zen 3 architecture is keeping Intel's latest Alder Lake CPUs honest.

It wasn't until the Pentium era in the mid-1990s, however, that AMD attempted its own true in-house design, the ill-fated K5. Arguably AMD's first major failure, K5 arrived later than planned in 1996, missed its clockspeed targets, and generally couldn't compete with Intel's then protagonist, the Pentium Pro. AMD recovered with the K6 the following year and kept Intel honest right through until late 2003, often landing significant blows with chips like the K7, otherwise known as the first Athlon processor, but never quite knocking Chipzilla out. That brings us to a pivotal moment in AMD's history, the arrival of K8, the mighty Athlon 64.

Codenamed Clawhammer, the Athlon 64 was the first desktop CPU to deliver 64-bit instruction capability to the desktop. Not only that, but it also delivered outstanding per-clock performance at a time when Intel's Pentium 4 Netburst architecture was hitting a frequency wall. Once intended to scale all the way to 10GHz, Intel found clockspeed gains increasingly tough beyond 4GHz. The Athlon 64 wasn't just competitive, it absolutely trounced the Pentium 4.

K8 was killer in server systems, too, thanks to its advanced integrated memory controller and HyperTransport interlink, which made Intel's Front Side Bus and northbridge technology look every bit as antiquated as it was. K8 should have been the moment when AMD finally became Intel's equal. But, somehow, AMD let that advantage slip. As the years ticked by and K8 and its descendants aged, AMD's product execution got worse and worse. Not only did AMD fail to release a truly new core architecture for eight years following the original K8 but when it did make a major revision, taking K8 quad-core and calling it K10, AMD managed to add a serious flaw, known as the 'TLB bug'.

Due later this year, Zen 4 will pack 5nm technology and a massive 40 percent increase in single-core performance.

From there, the K8 line never truly recovered. By the late 2000s, something radical and new was required. That something turned out to be Bulldozer. Intended to be the once and future king of CPUs, Bulldozer instead became the villain of the AMD story, the architecture that nearly brought the company down. Released in late 2011, Bulldozer was by many measures the most advanced and forward-thinking PC processor AMD, or any other company for that matter, has ever produced. It unceremoniously ditched conventional thinking around CPUs containing multiple almost entirely discrete CPU cores in favour of a much more complex and highly integrated architecture designed around modules.

Each module contained a pair of integer units and shared not only its instruction decode and retire hardware but also L1 and L2 cache along with a single floating-point unit. Unlike anything AMD and Intel had produced before, the thinking behind Bulldozer was to produce smaller, more efficient chips that would deliver exceptional multi-threaded performance for a given die area.

Bulldozer issues

Marketed as the AMD FX, part of the problem with Bulldozer was that it didn't contain conventional cores that could easily be compared with Intel's CPU or even AMD's legacy designs. The first top-of-the-range FX 8150 chips packed four Bulldozer modules, but AMD chose to pitch them as eight-core CPUs. While a Bulldozer module was clearly more complex than an Intel CPU core, such were the extensive shared resources in each dual-integer module that single-core performance was disappointing despite running far higher 4.2GHz peak clockspeeds compared to its predecessor, and indeed, Intel's 3.8GHz Core i7-2600K competitor.

And when we say disappointing, we mean it. Not only was Bulldozer slightly slower than AMD's elderly and outgoing Phenom II K10-based CPUs when it came to single-core workloads, but Intel's 2600K was also roughly 50 percent faster. Compounding the single-core performance problem was the fact that the PC software ecosystem had yet to fully embrace the multi-threaded model, something that was particularly true of games, not least because the prevailing iteration of Microsoft's DirectX multimedia API had poor support for multi-core CPUs.

The upshot? Bulldozer had limited opportunity to do its multi-core thing. But even when it could, it was more a case of closing the gap to the merely quad-core 2600K than actually overtaking it. Bulldozer definitely did not perform like a full eight-core CPU and it was, by any sane measure, a failure. The consequence for AMD's business was catastrophic. In 2012, AMD lost over $1billion. By mid-2015, most industry observers were predicting AMD would go bankrupt. In total, it took five long years for AMD to return to profit.

The story of how AMD turned things around from the Bulldozer debacle obviously centers on Zen, the CPU architecture that saved the company. But there's plenty more to AMD's revival besides. Indeed, some aspects of AMD's recovery date back to long before Bulldozer appeared, let alone Zen. In 2008, AMD announced plans to spin off its in-house foundry, the part of the company that fabricated CPU dies, into a new, separate entity known as Global Foundries.

> "Marketed as the AMD FX, part of the problem with Bulldozer was that it didn't contain conventional cores that could easily be compared with Intel's CPU or even AMD's legacy designs."

At the time, the move looked like a desperate measure to inject funds into an increasingly cash-starved business than a positive long-term strategy. However, the latter is exactly how things have now turned out. When AMD ditched its own fabs, Intel had long been the undisputed world leader in chip production. More recently, Intel's fabs have been in serious trouble. Its 10nm node has taken so long to come up, that Intel felt the need to rebrand it 'Intel 7' to make it look more competitive. Intel 10nm was at least five years late when it came fully on stream last year.

All the while, AMD has been a customer of TSMC, the Taiwanese foundry that now has a clear edge over everyone else when it comes to process technology. Such is TSMC's current technological advantage, Intel has made the humiliating move of announcing plans to farm out some of its own chip production to the Taiwanese outfit. Admittedly, TSMC's 7nm node is probably only comparable to Intel's 10nm node in terms of transistor density and efficiency. But AMD was able to start producing CPUs on the TSMC 7nm

AMD's Ryzen mobile CPUs are even more competitive than its desktop chips.

AMD's RDNA 2 cards pack a punch, but RDNA 3 will be the next big leap forward when it arrives later this year.

in mid-2019. It would take Intel another 2.5 years to launch its first 10nm desktop processor, the 12th Gen Alder Lake CPU.

TSMC advantage

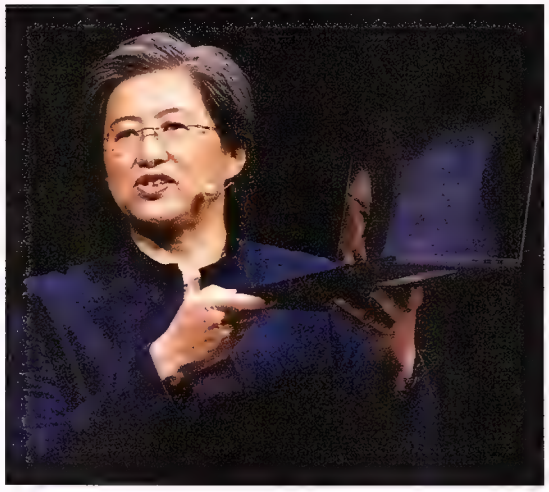
Making matters worse for Intel, TSMC has actually been producing chips on its even more advanced 5nm node since 2020 for other customers, most notably Apple. AMD is due to launch its first 5nm CPU later this year. We don't expect Intel to release TSMC's-produced CPUs until at least 2023 and it's likewise doubtful whether we'll see chips based on Intel 4, the direct competitor to TSMC 5nm, before the end of next year, either. In short, it turns out that selling off its fabs and partnering with TSMC has given AMD a huge advantage in terms of production technology. Maybe that was planned. Maybe it was luck. But it's been absolutely critical all the same.

Another part of the current recovery that actually began before the Bulldozer debacle involves graphics. Back in 2006, AMD snagged Canadian graphics outfit ATI. At the time, the deal looked dubious, not least because AMD paid a cool US$5.6 billion in cash and shares for ATI, or around half of what AMD itself was worth at the time. Not only was the acquisition a real stretch financially, just 18 months later, AMD had written down nearly US$3 billion of that investment in ATI, which was over half of its value gone.

It looked like a disaster. If those early ATI numbers were a fiscal car crash, the long-term strategy was actually sound. Acquiring ATI put AMD in the unique position of being able to offer both high-performance processors and cutting-edge graphics. Intel's graphics capabilities were limited at the time and even now it has yet to prove the new Arc project will amount to truly competitive GPUs. Meanwhile, not only has Nvidia lacked an x86 CPU product of any kind, it lacks the licensing required to even contemplate competing in that market.

As it happens, one of the most obvious direct benefits to AMD of that CPU-GPU nexus enabled by ATI involves not the PC, but consoles. Thanks to AMD's unique ability to offer its customers both processing and graphics, in 2013 not only the Microsoft Xbox One but also Sony's PlayStation 4 were launched with AMD power. Admittedly, per-unit revenues for AMD from consoles at the time were thought to be puny. However, with millions of consoles sold AMD was pulling in vital cash. By the end of 2013, AMD actually turned a profit for a quarter or two, despite its core CPU business still shrinking at the time.

With Ryzen, AMD has taken laptop design wins with the big boys, including Dell, HP, and Asus.



Granted, AMD's losses continued to swell through 2014 and 2015. But the console deals provided a vital flow of money during its most precarious period. Those console design wins had other benefits besides the pure cashflow. First, those console APUs, which combined AMD's low-power Bobcat CPU cores with its GCN or Graphics Core Next graphics IP, proved that AMD could adapt and integrate both halves of its main businesses into a single-chip product with bespoke elements for customers. Owning the IP in both major consoles also meant that nearly every significant game was built primarily to run on AMD's GCN graphics architecture, including most triple-A PC games.

If those are background stories, the most important elements of AMD's new dawn actually fell into place remarkably soon after the release of Bulldozer. As the late 2000s bled into the early 2010s and the Bulldozer era, AMD was running out of options with its existing product lines.

The foundries had been sold off, while opportunities from ATI's graphics IP had been maxed out on

console and ATI's mobile graphics IP had been offloaded at arguably far too low a price to Qualcomm. Incidentally, the result of that particular fire sale was the Adreno graphics core found in so many smartphones today. Adreno is, of course, an intentional anagram of Radeon, ATI's, and then AMD's consumer graphics brand.

Whatever, there was nothing AMD could do but dig out of trouble the old-fashioned way, by building better products. But better products don't just appear. Living, breathing people make them. And that's precisely where two key figures enter the equation, Lisa Su and Jim Keller. You can read all about Lisa Su's contribution in the boxout on page 62. But the short version is that her leadership has been critical in AMD's renaissance. If AMD wouldn't have begun without Jerry Sanders, it wouldn't have survived without Lisa Su.

As for Jim Keller, without his contribution, AMD would have struggled to turn the corner, too. Keller, of course, had been at AMD before, most notably as the lead architect on the now mythical K8 or Athlon 64. Since his last posting at AMD, among myriad other things, Keller did a stint at a certain computer outfit known as Apple. Anyway, Apple is famously secretive about almost everything. But many industry observers credit Keller with key elements of Apple's A4 and A5 iPhone and iPad SoCs.

The A5 in particular laid the foundations for what has become Apple's utterly dominant position when it comes to smartphone performance and efficiency. Ironically, that technical advantage is now spilling over into full-function computers as Apple transitions its Mac systems to in-house silicon derived from that same line of iPhone and iPad chips.

So, while Keller certainly made a huge contribution to AMD's revival, it could be his work while he was with Apple that eventually poses the greatest challenge to AMD's current business model, especially if it forces the PC industry to adopt ARM technology.

If that's a story for another day, what has mattered for AMD's revival is Keller's involvement with Zen, the CPU architecture that turned AMD's fortunes around. As Keller himself says, his primary contribution isn't typically the nuts and bolts of a chip's architecture, though we suspect he's pretty knowledgeable when it comes to those elements. Instead, Keller has always emphasised his role in getting people working together effectively.

Growing authority

According to an interview with Keller last year, he took the job at AMD on the proviso that he would be given broad authority for developing what was to become AMD's savior, the Zen architecture. When he arrived as CPU president at AMD in 2012, he had 500 people under him. By the time he left in 2015, that number had swelled to 2,400. As Keller quipped, with that many people under his command, he was "hardly writing RTL (the low-level abstraction that allows chipmakers to lay out the very wiring of a CPU)".

Keller says he operated under the assumption that everything about Bulldozer was bad. He wanted a clean slate and any existing technology needed to prove itself worthy of inclusion in future products. But as critical as his role clearly was, he resists the idea that he was the 'father' of Zen. In fact, Zen was designed by hundreds of engineers including an SoC team split between Texas and India, a group in Colorado was responsible for the floating-point cache, another in Texas did the core execution front end, while the architecture's broad methodology team was spread across the world.

Still, Keller's influence on Zen is undeniable and it's likely that every iteration of Zen so far, including the latest Zen 3 architecture in today's Ryzen 5000 Series chips, was laid out in at least broad terms as part of the long-term roadmap developed under Keller's leadership. Everything we've seen so far from Zen is a Keller-era chip. All of which just leaves the minor matter of what

TSMC's advanced packaging technology could be critical to AMD's future success.

HOW DID AMD END UP WITH TOTAL ACCESS TO INTEL'S PRECIOUS X86 ISA?

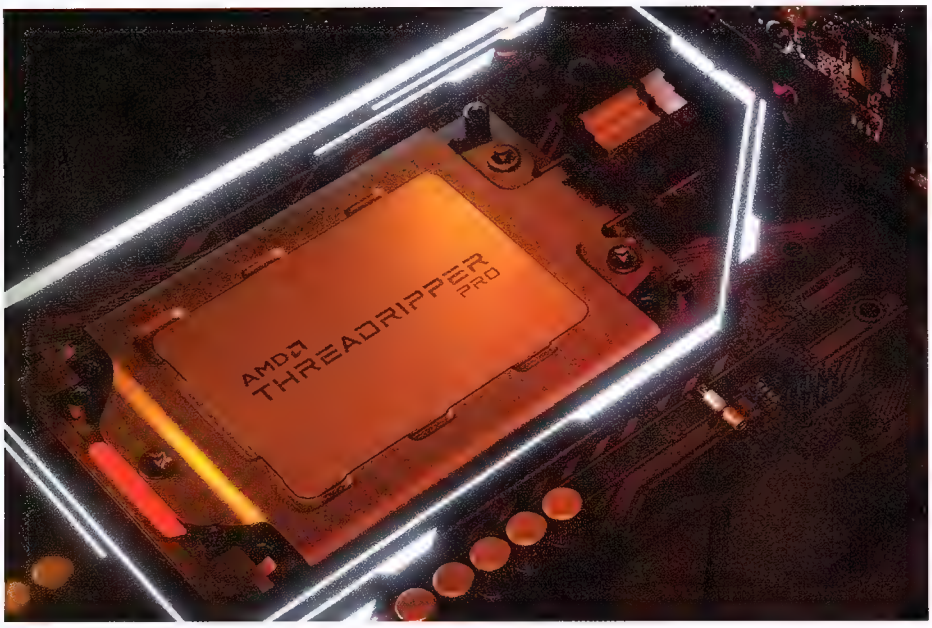
In the early days of desktop computing, the market was awash with competing and indeed incompatible microarchitectures.

But IBM was on a quest for broad software compatibility, a vision it rightly thought would accelerate the adoption of desktop PCs. So, when IBM selected Intel's 8086 architecture for its nascent PC, it also dictated a 'second source' supplier for the very same CPU. Enter AMD as that second source supplier, manufacturing direct copies of the Intel 8086 under license.

When Intel declined to extend that license to include the 386 successor to the 286 in the mid-1980s, AMD was forced to reverse engineer the chip. Intel sued, lost, and eventually agreed to a license that allowed AMD to build chips around Intel's x86 instruction set so long as it didn't directly copy the architecture of its CPUs.

If that licensing arrangement inevitably involved money in Intel's direction, all that ended abruptly in November 2009. Thanks to Intel's adoption of AMD's 64-bit extension of the x86 ISA, the original creator of x86 was no longer in a position to demand royalties from AMD and a comprehensive, royalty-free, cross-license platform was agreed upon. AMD is free to use x86, Intel is free to use x86-64 and neither pays the other party a cent.

AMD's 64-bit extensions to the x86 ISA have put it on an equal footing with Intel.



AMD's chiplet technology has enabled ThreadRipper CPUs with crazy core counts.

makes Zen tick? Why has it been such a smash hit CPU design?

Revealed in February 2016 but not actually available to buy in the form of the Ryzen 1000 series CPUs until a year later, Zen was a ground-up new architecture just as Keller desired. In some ways, it was a more traditional design than Bulldozer and its highly-integrated descendants. Zen returned to discrete cores, each with its own fetch, decode, execution, and retire, plus L1 and L2 cache memory.

Pipeline dreams

In fact, the entire pipeline was redesigned with shorter, more responsive instruction pipelines for more performance per clock, thereby dumping Bulldozer's clockspeed-enabling deep pipeline design. The net result was over 50 percent improvement in performance per clock from each thread compared with Excavator, the final iteration of the Bulldozer line of CPU architectures, and something in the region of 80 percent better by that same measure over the original Bulldozer cores. Granted, it wasn't enough to beat Intel for single-threaded performance. But AMD was back in the game, quite literally given how important single-threaded performance is to gaming.

Just as important as radically improving per-core and per-clock performance with the original Zen architecture was the shift to multi-chip modules with Zen 2. Instead of producing the entire CPU on a single die, the Zen 2 processor package contains multiple so-called 'chiplets'. Zen 2's 'compute' die was built on TSMC's 7nm node and contained eight cores. That was paired with a central 'I/O' die manufactured on Global Foundries' cheaper 12nm node and connected via AMD's Infinity Fabric links.

The I/O die is a hub for all off-chip communications, housing the PCIe lanes for the processor, plus the memory controller and aforementioned Infinity Fabric links to further compute chiplets. Yep, further compute chiplets. In other words, with Zen 2 AMD could add another compute die and in an instant take the total core count up to 16, far more than Intel offered at the time for desktop customers.

That physical modularity would eventually allow AMD to introduce crazy core count chips for the high-end desktop market in the form of ThreadRipper CPUs, eventually topping out at fully 64 cores. Intel's hitherto monolithic designs do have some advantages. Chip-to-chip latency in an AMD chiplet design can create performance bottlenecks in certain scenarios.

But, crucially, Intel's monolithic approach makes it slow to respond. Where AMD can, in theory, simply insert another compute die full of cores into the CPU package, Intel must design, tape out and optimise a whole new chip if a core count increase is desired.

Comprehensive roadmap

The final part of the Zen puzzle is what you might call roadmap execution. AMD didn't just wheel out the original Zen architecture in the Ryzen 1000 series chips and then call it a day, something it was arguably guilty of with K8. Under Lisa Su's overall command, Keller and his team laid down a multi-year, multi-generation roadmap of architectures with planned improvements and upgrades. And more important than just about anything else, AMD then executed that roadmap flawlessly. No delays. No major bugs.

AMD's CEO shows off its upcoming Intel killer, the Zen 4-based Ryzen 7000 CPU.

In 2019 came the first really big upgrade in the Ryzen 3000 series and Zen 2. Although a development of the original Zen architecture and cores, it still increased single-thread performance by a hefty 20 percent and also upped the headline core count to fully 16 cores for mainstream desktop processors, far above anything Intel was offering. Just a few years earlier, when AMD was stumbling and Intel was allowing the CPU market to stagnate, four cores were the most you could have in this same segment. AMD was radically shaking up the market.

Next, in 2020 came Zen 3 in the Ryzen 5000 series. In many ways, Zen 3 is the Zen architecture fully realized. At a high level, it looks a lot like Zen 2. You have the same chiplet architecture with 7nm compute dies, each with eight cores, plus that 12nm I/O chiplet.

But every segment of the core has been redesigned, with major changes including wider INT/FP dispatch, larger buffers and execution windows, better branch prediction, and more. In total, AMD claims a further uptick in single-thread performance for Zen 3 of 19 percent compared to Zen 2.

But arguably the most important revision was to the layout of the eight-core compute die. Previous Zen CPUs had been composed of core complexes or CCXs containing four cores. Within a CCX, each core has its own L1 and L2 cache, while L3 cache is shared across the four cores. Of course, Zen CPUs contain more than four cores. The problem came when a core in a separate CCX needed access to data stored in the L3 cache of another CCX. That created cache latency and impacted performance.

For Zen 3, the CCX size has been increased to eight cores. So, any Zen 3 chip with up to eight cores entirely avoids that occasionally debilitating CCX-to-CCX L3 cache

© Xbox Game Studios, nvidia

latency. That's particularly important for applications like gaming that are acutely sensitive to cache performance. Workloads that more neatly lend themselves to parallelisation, such as video encoding, aren't nearly as sensitive to cache latency. So, performance was already scaling very nicely with AMD's earlier quad-core CCX designs and indeed multi-chip CPU models.

Did we mention that as these desktop chips were rolling out, AMD was also making serious headway into the laptop market for the first time? If anything, AMD's Ryzen APUs have been even more competitive. Partly that has been down to superior process technology from TSMC that is even more critical for mobile chips than desktop processors.

That advantage arguably reached its zenith in 2020 when AMD launched the 7nm Renoir Ryzen 4000 APUs for laptops. Thanks to the inherent efficiency of the Zen architecture, plus the superiority of TSMC's 7nm node and the integration of AMD's Radeon graphics technology, all the while Intel was struggling to bring its 10nm node online, AMD found itself with a killer mobile offering to which Intel had absolutely no answer.

> "AMD didn't just wheel out the original Zen architecture in the Ryzen 1000 series chips and then call it a day, something it was arguably guilty of with K8."

Renoir and its 2021 Cezanne successor are so much better than the Intel alternatives when it comes to both power consumption and performance, it allowed AMD to finally break into laptops in a big way. Mobile platforms have always been a tough nut to crack for AMD thanks to Intel's greater resources and ability to help PC makers integrate their chips into the thermal and physical constraints of a laptop. In the past, when AMD had managed to produce decent but not world-beating mobile CPUs, they made almost no impact on the market. But Renoir was so good that the biggest players in the PC market including Dell, HP, Lenovo, and Asus could no longer afford to ignore AMD. They had to build Ryzen into their laptops.

Full speed ahead

As if all that wasn't impressive enough, check out AMD's forward roadmap. Later this year, Zen 4 and the Ryzen 7000 series of CPUs is due. Not only will Zen 4 move to TSMC's more advanced 5nm node for the compute chiplets and 6nm for i/O, but it will also bring another big step in single-thread

NEAR BANKRUPTCY TO BILLIONS THE LISA SU STORY

On 8th October 2014, when Lisa Su assumed leadership of AMD as CEO, the company's stock price was running at US$3.25. Just over six years later, on 29th November 2021, AMD's stock hit US$164. That's an increase of 4,946 percent.

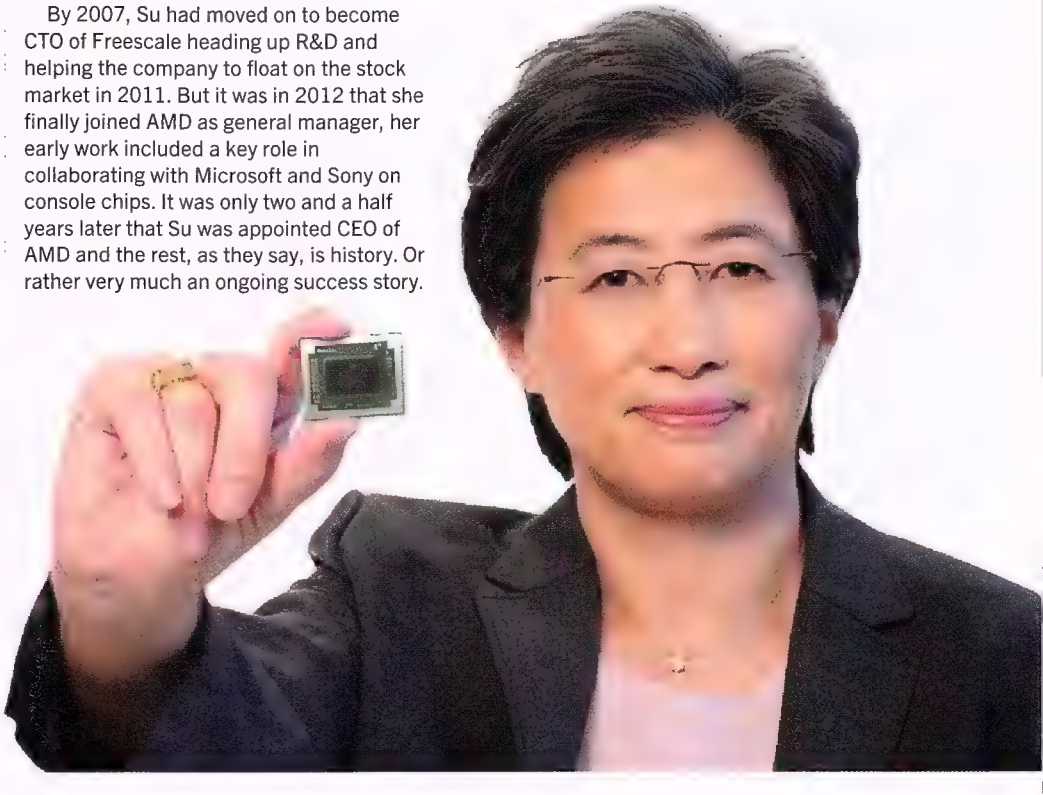
So, who is the woman behind AMD's revival? Born in 1969, Su came to the US from Taiwan aged just three. As a young girl, her statistician father and accountant mother schooled her in the way of numbers. By 10 years old, her engineering instincts had her rebuilding remote control cars and it seemed her destiny to enroll, as she did, at the Massachusetts Institute of Technology (MIT) in the fall of 1986 to study electrical engineering.

From the very start, those student days set the tone for her future role at AMD. In her freshman year, she spent time as a research assistant helping with the manufacture of test silicon wafers for grad students. Part of her doctorate research at MIT involved some of the earliest work on silicon-on-insulator (SOI) technology, a then unproven method of improving chip efficiency that is now industry standard.

Out of MIT, Su joined Texas Instruments and then, shortly afterward, moved to IBM, where she pioneered the replacement of aluminum connectors with copper, resulting in chips that were 20 percent faster. In 2000, Su was given a year-long assignment as technical assistant to IBM CEO Lou Gerstner before being appointed head and founder of IBM's Emerging Products division.

During that period, Sony CEO Ken Kutaragi commissioned Su's group at IBM with a collaboration charged with "improving the performance of game machine processors by a factor of 1,000." The result was the ground-breaking nine-processor chip that became the Cell CPU in the Sony PlayStation 3.

By 2007, Su had moved on to become CTO of Freescale heading up R&D and helping the company to float on the stock market in 2011. But it was in 2012 that she finally joined AMD as general manager, her early work included a key role in collaborating with Microsoft and Sony on console chips. It was only two and a half years later that Su was appointed CEO of AMD and the rest, as they say, is history. Or rather very much an ongoing success story.



Since taking over in 2014, Lisa Su's impact has been little short of stellar.

per-clock performance of around 25 percent. Factor in higher clockspeeds, in part thanks to that 5nm node, and per-core performance will be up by a massive 40 percent.

At launch, we're not expecting more than 16 cores. But a 24-core mainstream desktop Zen 4 product is possible, while Zen 4 ThreadRipper Pro CPUs with a staggering 128 cores are expected.

Further out than Zen 4, things inevitably get more speculative, at least from an outsider's perspective. Zen 5 is surely a done deal from a design perspective, but little is publicly known about its core architecture or features. But if there's something about AMD's plans we'd most like an inside take on, it's any alternatives AMD may be working on to replace ye olde x86 instruction set.

How so? Apple's M1 chips in its latest Mac computers have comprehensively proven that ARM CPUs can compete on not just efficiency, but pure performance. Now more than ever, ARM looks plausible as a replacement architecture for x86 in the PC. Back when Jim Keller was running AMD's CPU business, there were indeed plans to hedge for that precise scenario with a modular CPU platform known as Skybridge that supported both ARM and x86 cores. The ARM version of Skybridge was codenamed K12 and originally due in 2016, but never actually appeared.

"If there's something about AMD's plans we'd most like an inside take on, it's any alternatives AMD may be working on to replace ye olde x86 instruction set."

Last year, AMD's CFO Devinder Kumar said the company was "ready to go" with ARM CPUs if that's what the market required. For now, there are no announced ARM-based CPUs in AMD's roadmap. But we suspect Keller's work on K12 will position AMD well should the need arise. After all, it was that effort under Keller's leadership at Apple that laid the foundations for the all-conquering Apple M1 family of SoCs. If ARM does turn out to be critical in future, it also won't hurt AMD's chances that its rival Nvidia's attempts to acquire ARM itself have now failed.

If a transition to ARM for AMD and indeed the PC as a whole is a rather speculative notion, what we can say for sure is that AMD's prospects look better now than at any time in its history. Its current CPU products are as good as or better than Intel's by almost every relevant metric. And its graphics business is nearly as competitive as Nvidia's.

What's more, AMD's roadmaps for both CPU and graphics could well deliver it a clear performance and technological advantage over both of its key rivals by the end of this year. The best CPU and the best graphics chips from one company. The king of the PC? It's looking extremely likely that, by the end of 2022, it will be AMD. ■

SHOW ME THE MONEY JUST HOW BAD DID IT GET FOR AMD?

All our testing has focused on desktop graphics cards.

It's well known that AMD struggled in the mid-2010s. But just how bad did the cash crisis get? As the 2000s came to a close, AMD's business was turning sour. Profits of US$360 million in 2010 and US$491 million in 2011 flipped into a monumental loss of US$1.18 billion in 2012.

In 2013, the bleeding subsided somewhat with a loss of US$83 million, only for the losses to balloon once again to US$403 million in 2014, US$660 million in 2015, and US$497 million in 2016. That's a total of US$2.8 billion leaving the building over the course of six years. As for how close AMD came to folding, its cash balance of US$1.9 billion at the end of 2011 had shrunk to just US$716 million by mid-2016.

Clearly, that could not continue, which is why many industry analysts were predicting AMD would be bankrupt by 2020. Happily, that never happened and, by the end of 2017, AMD had begun to turn the ship with a small but symbolically important profit of US$43 million. In 2018, AMD had stopped the rot, returning US$337 million. A steady, if unspectacular, result of US$341 followed in 2019.

But it was 2020 that proved AMD had truly entered a new era of high profitability, clocking up US$2.49 billion of net income. The following year was even better at US$3.62 billion, with 2022 looking set to be even stronger, with a US$786 million profit in the first quarter, up a massive 42 percent on the same period in 2021.

If AMD carries on like that, it will breach the US$5 billion profit barrier in 2022. And memories of the flirtation with bankruptcy just a few years ago will have been erased.

The multi-billion-dollar chip: AMD's Ryzen CPU family.

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FEATURE

WORDPRESS OR WIX? WHICH IS RIGHT FOR YOUR PERSONAL WEBSITE?

Running a website needn't be a technical challenge. Nik Rawlinson compares the two leading platforms that can help anyone create and manage their own pages.

Publishing a personal website was once a costly and complicated business. Not any longer. User-friendly platforms such as WordPress and Wix let you publish online for free, and you might not even need to pay for web hosting. They give you everything you need to design and populate your site, maintain it and interact with visitors. It's estimated that nearly half a billion websites are built on WordPress, while upwards of 200 million people use Wix.

But which one should you choose? It's not a case of one being better than the other. They're fundamentally different products, approaching the task from different directions. More apt would be to look at the various jobs that a personal website publisher would need to undertake, to see how each handles them in turn.

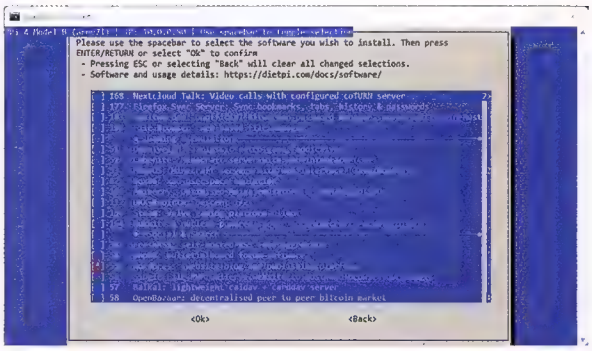
The best place to start is with hosting, as the choice you make there can determine on its own whether WordPress or Wix is the right choice for you.

Hosting options

You can host your site for free as a subdomain of wordpress.com – or if you already have your own web domain you can run it there, without paying a penny to WordPress itself. Many web hosts offer one-click deployment of WordPress, and they can also take care of tracking and installing updates to the WordPress software, along with any themes and extensions you've installed.

If your host doesn't offer an option such as this, you can upload and configure WordPress yourself. All you need is a server running PHP 7.4 or later plus either MySQL 5.7 or later, or MariaDB 10.2 or later, which few hosts will have trouble with. You'll need to take care of creating the database and setting up a database user, through a dashboard or a tool like phpMyAdmin, then uploading the WordPress files to the root of the site (or a folder if appropriate), before editing the wp-config.php file so it contains your database login details. You then have full administrative control of the site through the dashboard – and will be responsible for making sure your themes and extensions are updated, and managing other tasks such as backup and customising the permalink structure.

It's also perfectly possible to set up WordPress on your home network, and to use a dynamic IP forwarding service such as noip.com to make it accessible from the wider world. If you want to go down this route, our advice would be to host your WordPress installation on a Raspberry Pi Zero 2 W, which is smaller than a credit card, yet more than capable of hosting a personal site while consuming only around 3W of power even when stressed. You can pick one up for around $20 and, if you do, we'd recommend installing DietPi (which is free from **dietpi.com**) rather than the official Raspberry Pi OS as it includes an easy menu-driven installer for WordPress, along with a wide range of other headless software.


Please use the spacebar to select the software you wish to install. Then press
ENTER/RETURN or select "Ok" to confirm
- Pressing ESC or selecting "Back" will clear all changed selections.
- Software and usage details: https://dietpi.com/docs/software/
<Ok>
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Install DietPi on a Raspberry Pi, and you can set up WordPress with a couple of clicks. Here, we're installing it remotely via SSH from the Windows command prompt.

The other option is to host your site at wordpress.com. This means you don't need to worry about configuring databases or keeping your site up to date, but if you take this route then by default your site will live within a subdomain, such as **mysite.wordpress.com**. If you want your own domain to point to a wordpress.com-hosted site, you'll need to pay $7 per month for the WordPress Personal plan; this also lets you remove wordpress.com ads, collect payments, perform basic design customisation and benefit from unlimited email support. There are also progressively more expensive Premium, Business and eCommerce plans, which increase the range of bundled features.

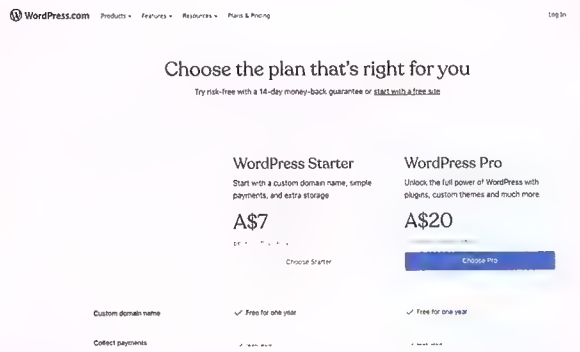
Wix also offers a free hosting service, though you'll end up with a slightly more complicated web address. It uses both a subdomain based on your username and a directory based on the name of your site. So, if your username is "myusername" and your site is called "mysite", your "about" page would be located at **myusername.wixsite.com/mysite/about**.

What it doesn't do is get rid of Wix's own ads: if you don't want to see these you need to spend $15 a month on the Combo plan, which doubles your bandwidth allowance, gives you 3GB of storage and 30 minutes of video storage. If you pay for a year up front and make full use of the advertising voucher, you could offset the cost of Combo entirely, but if your only aim is to use your own domain without ads then it's considerably more than the $7 WordPress wants.

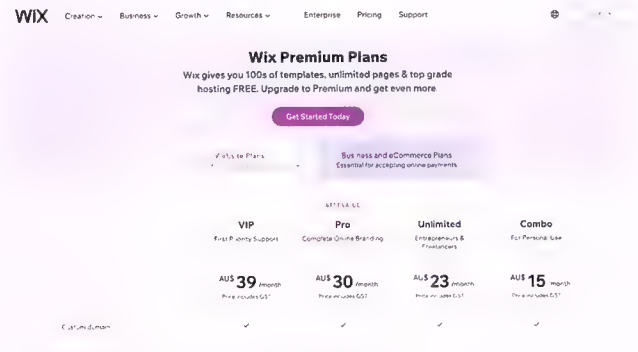
Setting up your site

If you choose to host your site at wordpress.com, you'll be walked through a three-stage process that involves providing your email address, choosing a domain (whether a free subdomain or paid commercial domain) and opting for a plan. The link to "start with a free site" is discreetly displayed at the top of the page, above the more conspicuous charged-for options.

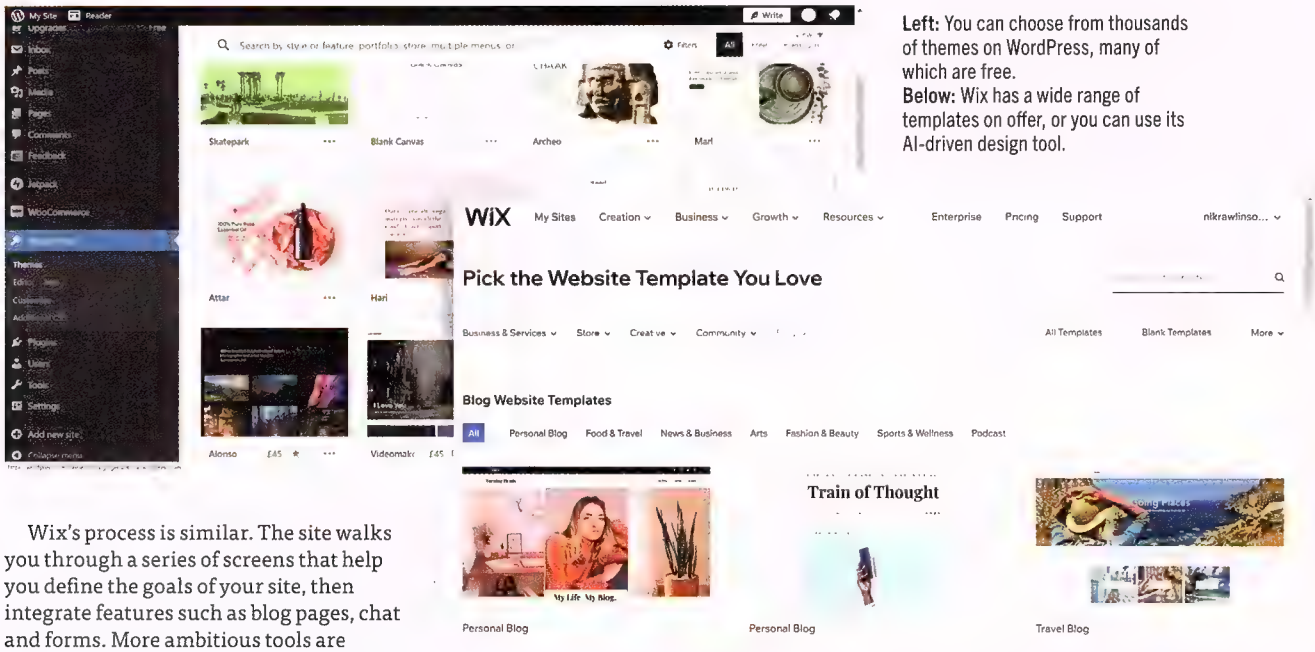
You can then immediately start designing your site, or creating an online store if you've signed up for a paid plan. Your first job is to choose a theme: plenty of suggested templates are shown, and you can preview what each one will look like when live. As soon as you've picked one, you're presented with a live placeholder site that you can edit and publish. When you're happy, you simply need to click through a few more pages – and past a few more exhortations to upgrade – and your site is online.


WordPress.com
Choose the plan that's right for you
WordPress Starter
Start with a custom domain name, simple payments, and extra storage
A$7
WordPress Pro
Unlock the full power of WordPress with plugins, custom themes and much more
A$20

You can host WordPress for free on your own domain or as a subdomain of **wordpress.com** – or opt for a paid plan with more features.



As with WordPress, you'll need to pay to remove the supplier branding from a Wix site.



Left: You can choose from thousands of themes on WordPress, many of which are free.
Below: Wix has a wide range of templates on offer, or you can use its AI-driven design tool.

Wix's process is similar. The site walks you through a series of screens that help you define the goals of your site, then integrate features such as blog pages, chat and forms. More ambitious tools are available too, such as music streaming and the ability to take food orders and sell memberships. Be warned: it may not be obvious at the time, but some of the features offered here are premium tools that need to be paid for.

Once you've chosen your elements, you can start building your site using the Wix Editor, which offers large thumbnails and full-screen previews to give you a clear idea of what the finished product will look like. Alternatively, you can take advantage of the new Wix ADI, which uses AI to come up with an appropriate design for you.

If you already have a website, ADI will offer to import its content. In our case we clicked past this, and were presented with six theme options, each of which is shown as a single font and colour. Hovering over each one gives a short description, and once you've chosen one you can choose from a selection of suggested layouts. It's a good idea, though the theme descriptions are too brief for our liking, and if you change your mind and hit the Back button you'll be returned right to the start of the ADI process.

When you've chosen your layout, you can easily add pages for "about", "contact", an Instagram feed and so on, then go on to edit and publish your site.

Maintaining your site

Both WordPress and Wix offer administrative dashboards, featuring a wide range of tools for managing, maintaining and monitoring your site.

The approaches are slightly different, however. WordPress distinguishes between "pages" – which are the permanent fixtures of your site, such as "about" and "contact" pages – and posts, which are more immediate and analogous to blog entries.

You can organise posts into categories and tag them; these variables will be automatically used to populate category pages and help readers to find related content, though note that not all themes have category or tag pages, or tag links at the bottom of posts. If you're self-hosting and happy to wade into the code you can easily add your own; the WordPress back end is minutely documented, and you'll find plenty of users keen to help in forums and on sites such as stackexchange.com.

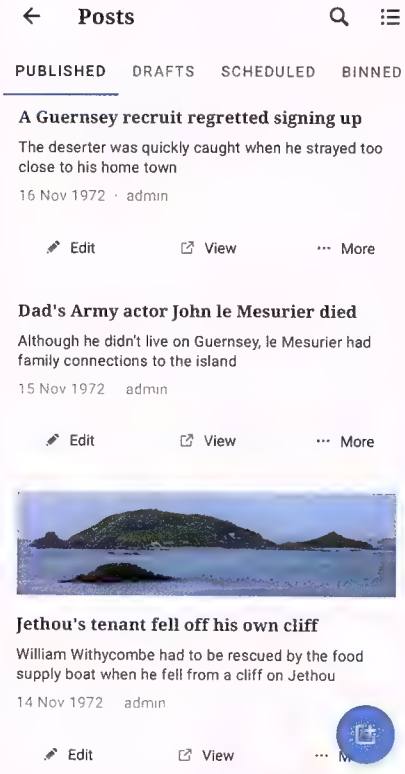
You can't dig into the code if you're publishing at wordpress.com, beyond adding custom HTML blocks to pages. However, you can use the Customiser (as you can when self-hosting) to adjust individual components of a template, such as the position and make-up of menus and titles. Again, exactly what is and isn't customisable varies between templates.

You can also choose whether to use the "Classic" writing screen to compose and edit your pages and posts, or to use the Block Editor, which lets you mark out sections for images, headings, text, galleries and so on, which can be rearranged at will. The latest release even introduces a block-based Site Editor tool (currently in beta testing), which lets you use blocks to build and reorganise entire pages, rather than only content spaces.

If this all sounds complicated, don't worry: there's no need to edit the site design at all if you don't want to. You can just switch to a different template when you feel like a change and instantly give your pages a total makeover. There are hundreds of free themes to choose from, so even if you're not paying for your site, there's no reason why it shouldn't reflect your personality.

Wix also distinguishes between blog posts and pages, and lets you tag posts and add them to categories. The post editor is similar to WordPress' block editor: click the floating plus sign on the page, and you can embed images, galleries, tables and more. As for tweaking templates, you don't have access to the underlying code, but you can embed code blocks, and add common elements such as contact forms, social media boxes and video players.

The site editor also lets you drag and drop a range of elements directly onto the page; hover over the live page and live guidelines show where an element will


Posts
PUBLISHED
DRAFTS
SCHEDULED
BINNED
A Guernsey recruit regretted signing up
The deserter was quickly caught when he strayed too close to his home town
16 Nov 1972 · admin
Edit
View
More
Dad's Army actor John le Mesurier died
Although he didn't live on Guernsey, le Mesurier had family connections to the island
15 Nov 1972 admin
Edit
View
More
Jethou's tenant fell off his own cliff
William Withycombe had to be rescued by the food supply boat when he fell from a cliff on Jethou
14 Nov 1972 admin
Edit
View

The WordPress app helps manage posts and monitor stats.

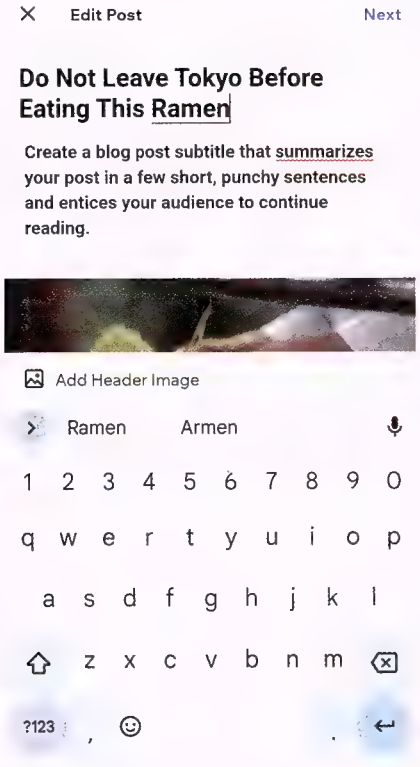
The Wix Editor has a very app-like look and feel.

appear once released. These also appear as you reposition and resize elements, so you can check that they properly align with other objects on the page.

Floating toolboxes, meanwhile, can be turned on and off, giving you the option of more fine-grained adjustments by typing in values – for example, you can shunt an image a certain distance to the side, rather than trying to drag it with pixel-perfect precision. If you want to create a bespoke site but don't know how to code, it really doesn't get much easier than this.

Extending your site

Both Wix and WordPress let you go beyond the basics by extending their core features.


Edit Post
Next
Do Not Leave Tokyo Before Eating This Ramen
Create a blog post subtitle that summarizes your post in a few short, punchy sentences and entices your audience to continue reading.
Add Header Image
Ramen
Armen
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q w e r t y u i o p
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z x c v b n m
?123

The Wix Owner app lets you administer your site on the move.

The Wix App Market is neatly categorised and easily searched, with a full description on hand for every app. There's plenty of free content, but also a fair number of commercial add-ons, which don't always have a free tier or trial. A busy reviews system allows users to share their views, and gives developers an opportunity to respond to comments directly.

When you add an app to your site, Wix warns you exactly which aspects of your code and content it will have access to; once integrated, an app has similar controls to the rest of the editing interface, so it can be easily repositioned by dragging, and tweaked using floating control panels.

WordPress also offers a mix of free and paid-for plugins through the site dashboard. However, if you're hosting your site at wordpress.com, then plugins – even free ones – require a business subscription. This costs a steep $20 per month; it's disappointing that even those paying for a Personal plan are excluded. For self-hosting, no such restriction applies. You can install plugins directly from the dashboard or upload them to your server manually. As with the Wix App Store, there's an active community of users rating plugins in the catalogue, which can be handy as there are often multiple options that do similar things.

Managing on the move

WordPress offers apps for iOS and Android, which let you access and manage multiple sites on the go. You can upload images from your phone, write posts or pages (and continue working on drafts you started in the browser), and track your access statistics. There are matching desktop apps for Windows, macOS and Linux.

WordPress also publishes an app for its JetPack plugin; available for both self-hosted and wordpress.com sites, this helps you focus on statistics, comments, likes and follows, and can alert you to important site events such as a spike in traffic or downtime.

Optional tools include site backups, spam protection and performance optimisation.

The Wix equivalent is its Owner mobile app, which likewise lets you write new blog posts, edit existing ones, track your stats and perform a number of behind-the-scenes tasks, such as managing users and sharing posts to social media. This latter feature is particularly neat, with a built-in image-creation tool allowing you to make eye-catching graphics optimised for social media that you can post using the apps already installed on your phone.

Which CMS is right for your personal website?

Whether you choose WordPress or Wix, each package contains all the tools you'll need to design and deliver a striking website. If it's practical for you, self-hosting gives you the most freedom and control over your site, which in our view makes WordPress the obvious choice. The fact it can be downloaded for free and is so widely supported means that, even for beginners, it's an easy introduction to running web apps.

However, not everyone is in a position to run their own site. If you're looking for a hosted solution, then wordpress.com may at first look like the obvious choice, since it's free. However, the fact that you can't install plugins without an expensive subscription means it could well hold you back once you start wanting to develop your site.

A hosted Wix solution also provides a more app-like experience, where tweaking a template feels like designing a page for print in DTP. WordPress' block editor for posts and pages narrows the gap, but in our view Wix still has the edge.

It is worth noting that Wix isn't ideally suited to big projects. Officially, Wix sites are capped at 100 pages, and even if you're within this count, Wix warns that adding pages can affect loading time and performance. There are get-arounds, such as building dynamic pages that draw content out of a database, but WordPress is better suited to managing large sites by design.

Clearly your choice of site platform is a nuanced one. If you want to self-host, WordPress is your only option, and it promises easier options for future growth. However, for a slick all-round experience, Wix shines through. The interface is attractive and easy to use, making it a stronger choice for less experienced users, as well as anyone who feels comfortable using page layout software for print.

In the end, you do need to make a decision: once you've built a site in Wix or WordPress, there's no simple way to migrate it to the other platform. However, since both services offer free accounts, you can test the waters by trying out the various tools and features on offer, and optionally upgrade to a paid-for service once you're ready to make a commitment. ■

COVER FEATURE

WINDOWS 11
MAKE IT PERFECT

It's been a year since Windows 11 was announced, but many bugs remain. We show you how to fix them and give a Jon Honeyball progress report.

Early adopters of operating systems are always canaries in the mine. It's been a year since Windows 11 was announced and many months since it was launched, but the operating system still has some sizeable holes.

From signing in without handing over an email address, to being barraged by unwanted apps, to shrunken menus, to performance problems, Windows 11 remains a sticky work in progress.

Here, we're going to show you how to overcome many of the bigger problems with Windows 11, hopefully making your computing life a tad easier. Whether it's fiddling with settings, tweaking the Registry or using third-party apps, there's usually a workaround for many of the problems that Windows 11 presents.

We've also got an end-of-first-year report from Headmaster Honeyball, who pulls no punches. "Must try harder" doesn't even begin to cover it.

CAN'T SET UP WITHOUT A MICROSOFT ACCOUNT

Gone are the days when Microsoft was quite happy to let you sign into Windows with a regular username and password. Recent versions of Windows have made it harder and harder to get through setup without signing up for a Microsoft account, and Windows 11 makes it seemingly impossible if you're using the Home version. However, there are ways in which you can beat Microsoft's dogged determination to make you set up a Microsoft account.

For Windows 11 Pro users, it's relatively straightforward. When you get to the screen begging you to enter your Microsoft account credentials or to create one if you haven't already down so, click on the ambiguously titled "sign-in options" link instead. The next screen will let you create an offline account.

For Windows 11 Home, you need to turn the cunning up to 11, too. One way to do it is to disconnect from the internet during the Windows 11 setup process. However, Microsoft has seen this coming, and so if you're connecting via Wi-Fi and can't physically disable the radio, Windows 11 will simply refuse to let you bypass the screen that demands you choose a Wi-Fi network.

Let's add your Microsoft account
One account connects your device across Microsoft apps and services, like Office, OneDrive, Microsoft Edge, and the Microsoft Store.
Microsoft
Sign-in options
Sign in with a security key
Only choose this if you have enabled a security key for your account.
Forgot my username

Microsoft is desperate for you to set up an account to use Windows 11.

Do not surrender at this point. Instead, press Shift-F10 to open a command prompt on the Wi-Fi network screen and enter the following command:

taskkill /f /im oobenetworkconnectionflow.exe

That should kill the internet connection and let you enter a username instead.

An alternative method is to enter a fake email address when you reach the screen demanding your Microsoft account credentials. Entering either "test@test.com" or "a@b.com" as your email address and any password you like will trigger Windows to offer you the opportunity to enter an offline username instead.

Isn't it daft you have to play such silly games simply to use a computer in the manner of your choosing?

WIDGETS GETTING IN THE WAY

Widgets have predictably turned out to have been the biggest waste of effort since Piers Morgan's conscience. If you can live without the baseball scores and third-hand celebrity gossip taking up a third of your screen, Widgets are reasonably easy to remove from view.

If you right-click on a blank space on the Taskbar and select Taskbar Settings, you'll see an option to switch Widgets off, which effectively hides the widget button that appears on the Taskbar.

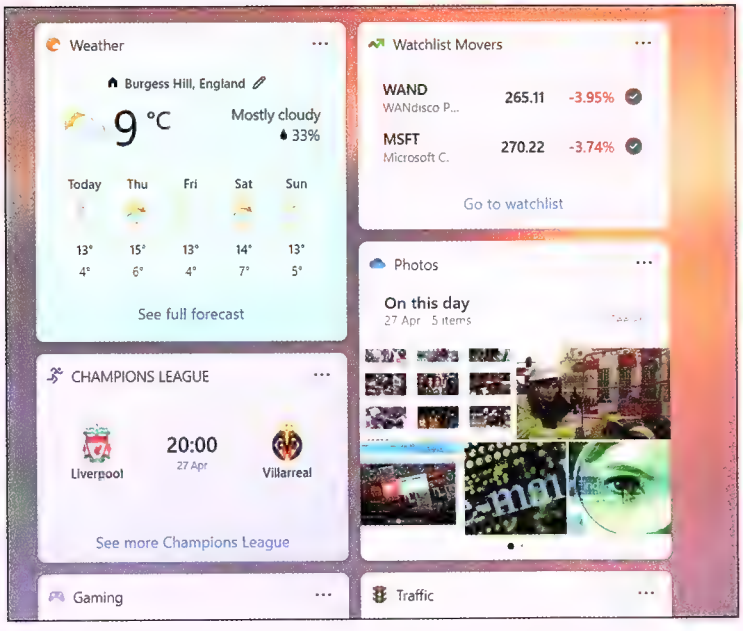
> "There are ways in which you can beat Microsoft's dogged determination to make you set up a Microsoft account."

If you ever feel the need to find out how Jennifer Aniston looks now, you can re-open Widgets with the keyboard shortcut Windows-W.

YOU WILL USE TEAMS!

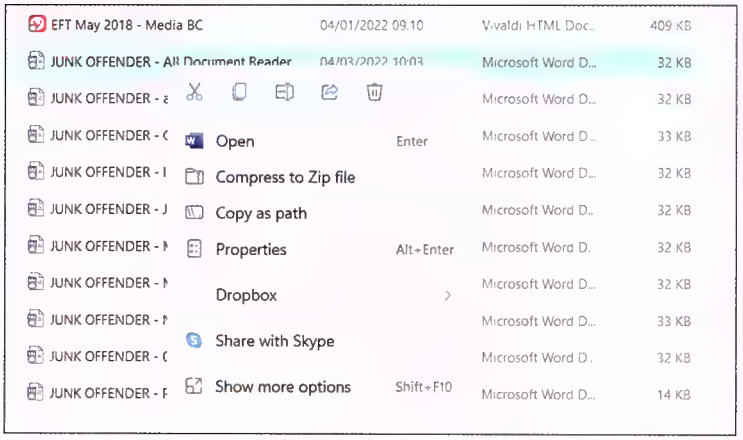
If you've spent any longer than 18 seconds in Windows 11, you will doubtless have been nagged about a dozen times to explore all the glorious magnificence of Microsoft Teams. Which is a pain in the gluteus maximus if you have absolutely no intention of ever using Microsoft's collaboration suite.

Sadly, there's not a single kill



Kill those irritating widgets for good.

Microsoft
Welcome to Microsoft Teams!
Chat and collaborate with co-workers using your work or school account.
Switch Teams app to sign in using a Microsoft account
Get started


EFT May 2018 - Media BC 04/01/2022 09.10 Vivaldi HTML Doc.. 409 KB
JUNK OFFENDER - All Document Reader 04/03/2022 10:03 Microsoft Word D... 32 KB
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Open Enter
Compress to Zip file
Copy as path
Properties Alt+Enter
Dropbox
Share with Skype
Show more options Shift+F10

Above left: Microsoft gives Teams a big (very big) push in Windows 11. **Left:** The right-click menu has been shrunk right down...

switch that will make all the Teams promos go away. But here are a few ways to stop seeing pop-ups, Taskbar icons and the like.

If you think you might need Teams one day but don't need it on a day-to-day basis, you can stop it running at startup. Go to Settings | Apps | Startup and switch off Teams from there (on our reasonably powerful laptop, Teams is described as having a "High impact" on system performance, which should be a cause of some embarrassment in Redmond).

If you're sure you'll never need the Teams app – it does run from a browser if you need to make a one-off video call, for example – then you can just remove the app. Our test laptop somehow managed to have two versions of Teams installed, so take care to check you've removed all of them. Search settings for "add" and click on the "Add or remove programs" option to get shot of it.

But hang on... what's that purple Chat button on the Taskbar? Ah, yes, that's effectively Microsoft Teams in sheep's clothing and, if you click on that, Microsoft will automatically reinstall Teams on your computer, which is jolly decent of them, eh? So, again, right-click on the Taskbar, choose Taskbar Settings and switch off chat. Then uninstall Teams again if it's crept back.

> "I'm about six zillion percent more likely to go to Google than the Windows 11 Start Menu if I want to search the web."

YOUR PHONE HIJACKING CALLS

The Your Phone app that's built into Windows 11 is actually extremely useful. It lets you send, read and respond to your phone's text messages from the computer, read phone notifications and easily access photos stored on your Android device. It also lets you place and answer phone calls from your computer instead of the phone, which can save you from having to fish your phone out of your pocket.

However, there are times when you might want to stop talking via the computer's speakers and microphone – if you have to leave your desk midway through the call, for example, or someone's entered the room when something sensitive is being discussed. It's not immediately obvious how you hand the call back to the phone in such instances.

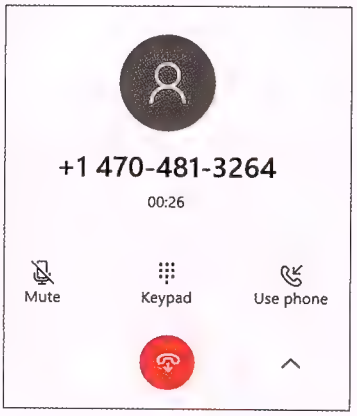
To do so, you have to click on the phone call's notification, which should be in the top right-hand corner of the Windows 11 desktop. When you do that, the notification expands and there you should see the option to Use Phone. Donk that and continue speaking via your Android handset without dropping the call.

CRIMPED RIGHT-CLICK CONTEXT MENUS

You always have to remember that Microsoft has to cater for a vast range of ability levels and that sometimes changes come at the expense of power users. One such compromise comes with the way right-click context menus are now handled.

If you right-click on a file in Windows Explorer, Windows 11 now presents a vastly curtailed list of options to what went before. You can still click to 'Show more options', but that puts handy features a further click away.

If you want to go back to the old-style list-as-long-as-your-arm menus, then you can do so with a Registry edit. All the normal caveats about fiddling with the Registry apply: if you screw it up, things can go badly wrong, so



The Your Phone app is useful, but can be disabled if you wish.

make sure you've got a backup to revert to.

Here's how to get those full context menus back:

1 Open the Start Menu and search for 'regedit', then open the Registry editor.

2 Navigate to the following path: HKEY_CURRENT_USER\SOFTWARE\CLASSES\CLSID

3 Right-click the CLSID key, select New and then Key.

4 Name the key: {86ca1aa0-34aa-4e8b-a509-50c905bae2a2} and press Enter to confirm.

5 Right-click the newly created key and select New and then Key once more.

6 Name this key InprocServer32 and press Enter.

7 Double-click on the Default key that you should see in the right-hand pane for your newly created InprocServer32 and make sure the Value data is set to blank. Click OK.

8 Restart the computer and you should have full-length right-click context menus back.

If you want to go back to the Windows 11 style, follow the steps above, but delete the key created in Step 4 and its contents. Tread very carefully when deleting keys to make sure you select the right one.

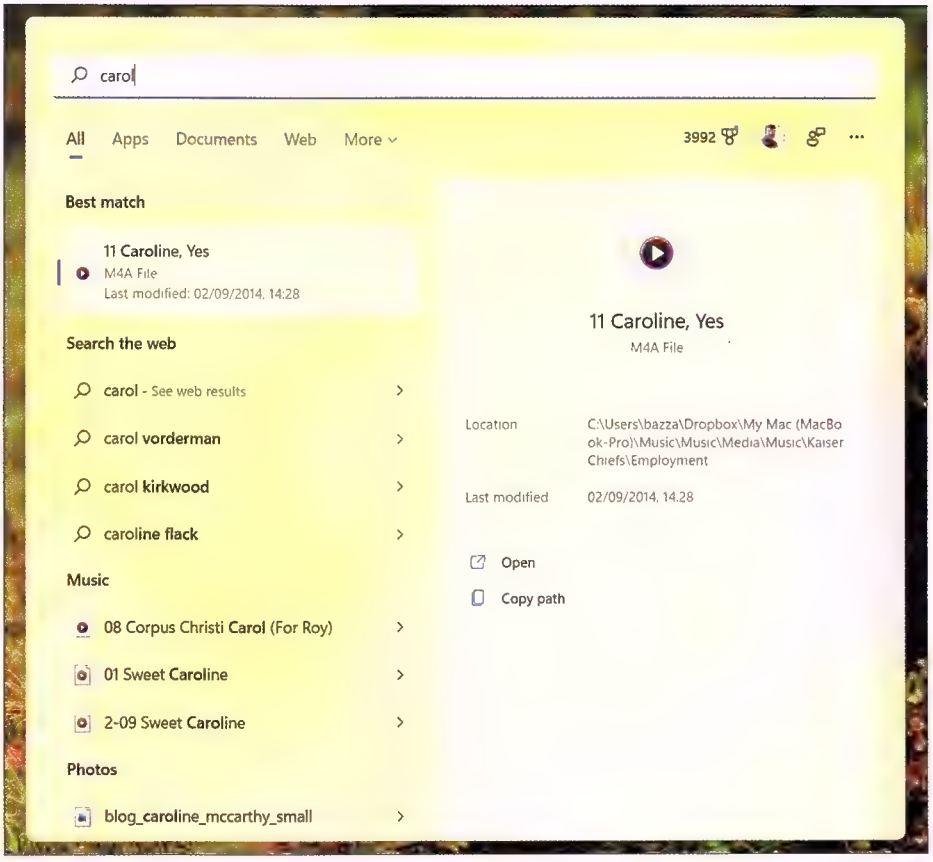
WEB RESULTS APPEARING IN START MENU

I don't know about you, but I'm about six zillion percent more likely to go to Google than the Windows 11 Start Menu if I want to search the web. Those web search results in the Start Menu just get in the way, but you can use another judicious Registry edit to make them disappear.

As above, make sure you've got a backup before you perform the following edit:

1 Open the Registry Editor and browse to the following path:
HKEY_CURRENT_USER\SOFTWARE\Policies\Microsoft\Windows

2 Right-click the Windows key and select New, then Key.



You can force Windows to perform only a local search.

3 Name the new key Explorer and press Enter.

4 Right-click on the newly created Explorer key and then select New | DWORD (32-bit) Value.

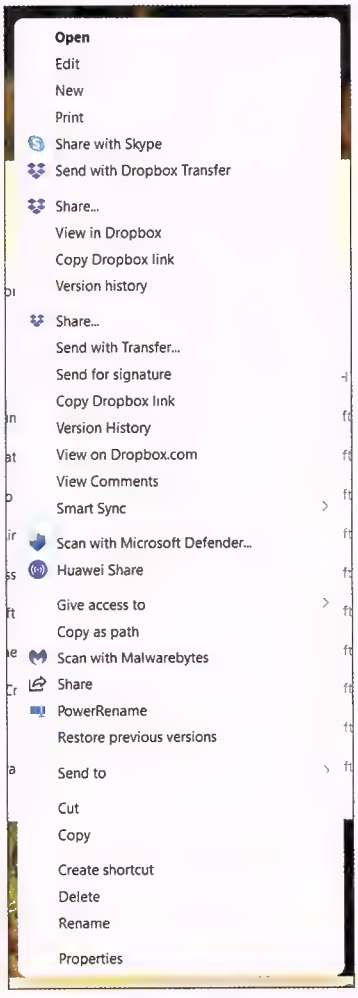
5 Name the DWORD that appears in the right-hand pane DisableSearchBoxSuggestions and then press Enter.

6 Double-click on that disableSearch BoxSuggestions key and change the value from 0 to 1, then click OK.

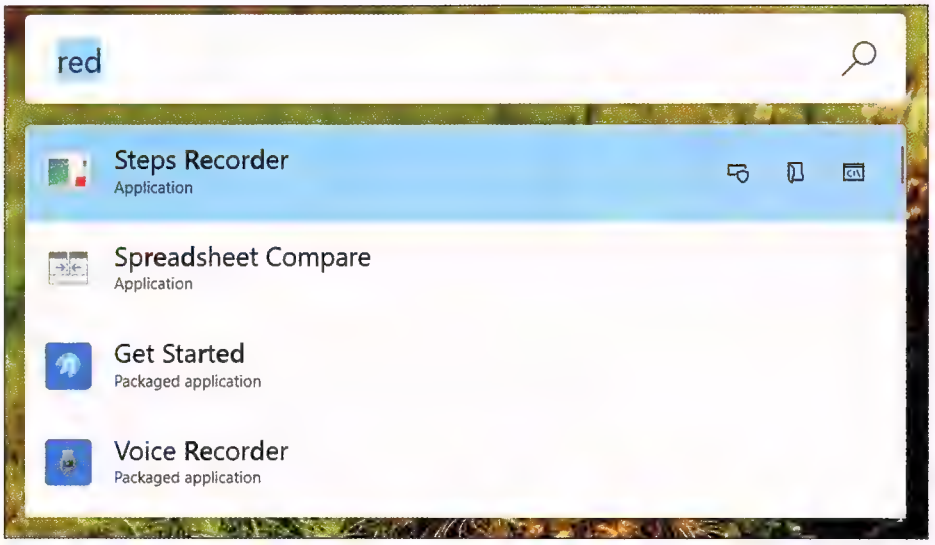
7 Restart the PC and rejoice at your web-result-free Start Menu. If you ever feel the need to get web results back, just change the value back to 0 in step 6 and restart your PC.

THE COMBO OF SEARCH AND START

We're not fully convinced the Start Menu is the right place for Windows search in the first place. If you'd rather keep search and Start separate, there's a PowerToy that gives Windows 11 a Mac-like search menu. You simply press Alt-Space and you're presented with a search overlay that lets you search for apps, files and settings without invoking the Start Menu at all.



...But you can expand it with a Registry edit.



Start and search have been combined, but you can change that .

You can download the Windows PowerToys from **tinyurl.com/APC509PT**.

The PowerToy in question is called Mac Spotlight, sorry, PowerToys Run. Once you've installed the PowerToys, right-click on the little coloured screen icon in the System Tray near the clock, choose Settings and decide which PowerToys to activate.

DISPLAYING SCALING IS OFF ON HI-RES DISPLAYS

Windows has suffered from scaling problems on high-DPI displays since (checks notes) about 1954. Seriously, Microsoft has long struggled to get this right, and Windows 11 shows little or no improvement on what's gone before.

If you're lucky, when you plug a 4K or higher display into your PC, everything is automatically adjusted and readable on screen. But even a cursory Google around the topic will find plenty of people complaining about onscreen elements being too small or blurry text.

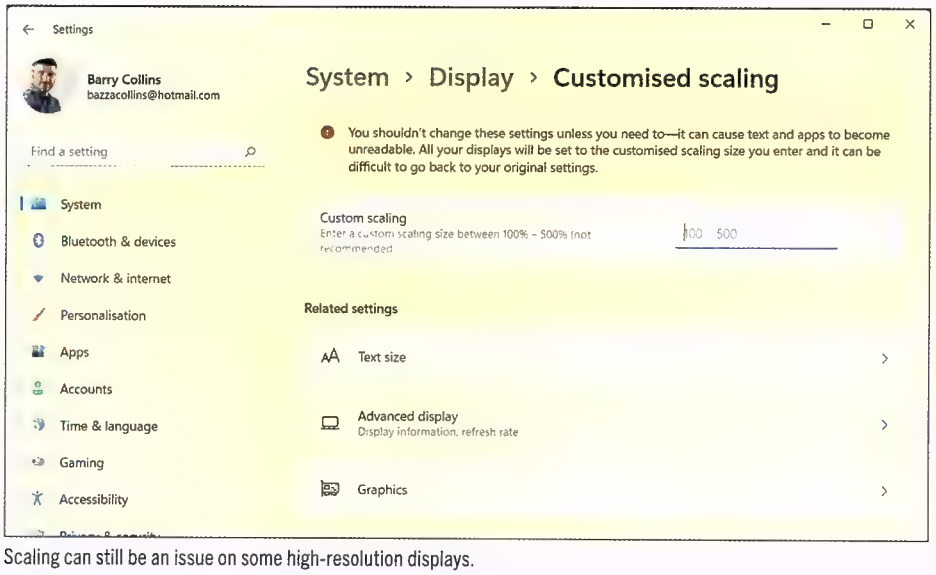
The Windows 11 settings add a further layer of confusion if you attempt to rectify display scaling. As our own Nik Rawlinson notes: "I usually run my laptop UI at 125 percent of the screen's native resolution (Windows recommends going even further, to 150 percent). However, when I plug into an external monitor it recommends not touching the scaling at all (in fact, actively warns against it). Is there any way to set custom scaling when using an external display? If not, why not just take this setting away?"

We'll be honest, we don't have a good resolution (sorry) to this problem. You can try fiddling with custom display resolutions, but you'll generally find the options available in the drop-down menu are the ones that cause the least graphical pain.

Microsoft's own advice on rectifying high-DPI scaling issues doesn't appear to have been updated since Windows 10, but its support pages recommend that "when you use multiple monitors (including when you dock or connect to remote screens), a greater difference in the resolution between the native device and external device is more likely to cause the [scaling] issues to occur." However, that's not something you always have full control over, especially in work environments.

If you're having problems with scaling as you move between laptop and external display, it may be best to rely solely on the larger monitor. Windows-P lets you scroll through the various options to extend the display or pick a particular screen.

It's also worth noting that in the System | Display | Scale settings, there's an option to boost the size of text on individual displays. This won't increase the size of things such as icons in apps, but it might be enough to let you use a high-DPI display more comfortably.


Settings
Barry Collins
bazzacollins@hotmail.com
Find a setting
System
Bluetooth & devices
Network & internet
Personalisation
Apps
Accounts
Time & language
Gaming
Accessibility
System › Display › Customised scaling
You shouldn't change these settings unless you need to—it can cause text and apps to become unreadable. All your displays will be set to the customised scaling size you enter and it can be difficult to go back to your original settings.
Custom scaling
Enter a custom scaling size between 100% – 500% (not recommended)
100 500
Related settings
Text size
Advanced display
Display information, refresh rate
Graphics

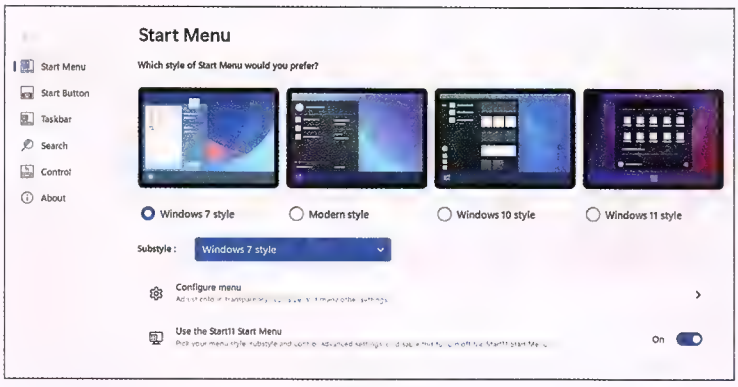
Scaling can still be an issue on some high-resolution displays.

THE START MENU/TASKBAR ARE ALL WRONG

The Windows 11 Start Menu and Taskbar handling has been almost as divisive as the B-word. If you're still wielding a pitchfork about what Microsoft has done to these crucial UI elements, inexpensive salvation is a mere download away in the form of Stardock's Start11 (**www.stardock.com/products/start11/**).

This $9.99 app lets you put the Start Menu and Taskbar back to how it behaved in previous versions of Windows. There are four different types of Start Menu to choose from: Windows 7, Modern (pictured opposite), Windows 10 or Windows 11.

Windows 11 might seem like an odd choice here, but Start11 gives you many more ways to customise the Start Menu than Microsoft does, letting you tailor the colours, background texture,



You can choose how your Start Menu looks with a simple app.

the shortcuts that appear and so forth. So if you're a broad fan of the Windows 11 styling, but want to, say, hide recent documents or adjust the level of Start Menu transparency, you can.

It's worth noting that if you miss Windows 10's Live Tiles, they're not brilliantly recreated here. There's no live data on tiles nor any real option to resize them.

Start11 also allows you to go back to an old-school Taskbar, complete with full tab labels and each instance of an app displayed in a different tab, if you wish. If you want the Windows 11 features, but have been put off by the look, Start11 is a very handy bridge.

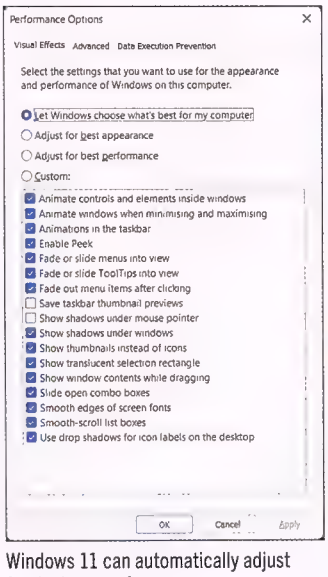
PERFORMANCE IS SLUGGISH

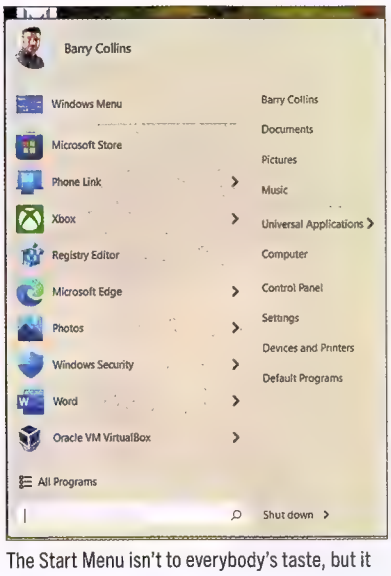
According to our repair shop guru Lee Grant, a common complaint among his customers is that Windows 11 performance is more sluggish than Windows 10, particularly on low-powered hardware.

To be fair to Microsoft, it did try to raise the bar on the minimum specs, which was met with howls of anguish from many Windows 10 users who thought they would miss out on a free upgrade. The company eventually relented to a degree and let people install Windows 11 on unsupported hardware, and that might well be the source of some of the grumbling.

As Lee advises, upgrading any old spinning-disk systems to an SSD might overcome some of the sluggishness, although it will do little to improve the slow redraws of UI elements that he often sees customers complaining about. For those victims, opening the Settings app, searching for "performance" and opening "Adjust the appearance and performance of Windows" might offer some salvation.

In that menu, choose "Adjust for best performance" and Windows 11 will drop many of the fancy animations and transparencies that drags down performance in the first place.


Performance Options
Visual Effects
Advanced
Data Execution Prevention
Select the settings that you want to use for the appearance and performance of Windows on this computer.
Let Windows choose what's best for my computer
Adjust for best appearance
Adjust for best performance
Custom:
Animate controls and elements inside windows
Animate windows when minimising and maximising
Animations in the taskbar
Enable Peek
Fade or slide menus into view
Fade or slide ToolTips into view
Fade out menu items after clicking
Save taskbar thumbnail previews
Show shadows under mouse pointer
Show shadows under windows
Show thumbnails instead of icons
Show translucent selection rectangle
Show window contents while dragging
Slide open combo boxes
Smooth edges of screen fonts
Smooth-scroll list boxes
Use drop shadows for icon labels on the desktop
OK
Cancel
Apply
Windows 11 can automatically adjust for the best performance.



The Start Menu isn't to everybody's taste, but it can be altered.

Windows 11 is one. Happy birthday?

Jon Honeyball delivers his damning verdict on Windows now that it's reached the grand old age of one.

So the bouncing baby has reached its first birthday. Cake and candles all round! Everyone gather round and sing a song of celebration! If only I could muster such feelings of joy.

I know it's sociably unacceptable to criticise any new offspring, but the only description I can muster for Windows 11 is "lipstick on a pig". Or piglet, I guess?

It shouldn't have been like this. Windows 10X as built was a ground-up new era operating system – 2020's answer to Windows NT (New Technology). Something aimed at ARM processors. A clean structural redesign, with all historical cruft removed. Precision-engineered for touch, and with the possibility of a smartphone implementation, too. Remember when the first target device was the Surface Duo, Microsoft's two-screen folding phone?

Except it didn't work out that way. Microsoft decided that Android was a better fit for Duo, in a move that surely made Steve Ballmer come out in a rash. Finally, in May 2021, Microsoft admitted that 10X was going nowhere.

Not that Microsoft put it like that. "Instead of bringing a product called Windows 10X to the market in 2021 as we originally intended," declared a half-buried blog post, "we are leveraging learnings from our journey thus far and accelerating the integration of key foundational 10X technology into other parts of Windows and products at the company."

Put that into Microsoft Translate and it becomes, "Windows 10 is receiving a facelift". Just like an ageing Hollywood star getting an overwrought bunch of surgery, the primary look and feel of 10X was bolted onto Windows 10 to create Windows 11. And just like most facelifts, it was the same old platform underneath if you cared to scratch the surface.

Windows 11 has been out for almost a year, and the rush to slap this new UI onto Windows 10 is evident most everywhere you look. Especially when you consider the rate at which Microsoft is trying to clean up the mess that this created. Functionality that went missing (such as Task Manager options) is slowly being bolted back in. There's an endless struggle to update older UI elements to the Windows 11 look and feel. And Microsoft is pushing the likes of Acer, Dell and HP to drop Windows 10 as quickly as possible.

Microsoft handled the transition story badly, locking out a whole raft of existing customers. And it was surprised when we squealed. The OS-curious jumped in to take a look, before many jumped back in horror. With no compelling reasons to upgrade, the most likely reason to "switch" is because you're buying a new computer so you might as well go with 11. Little wonder that take-up is flatlining, according to Statcounter. I can't see this changing. Corporate users will run Windows 10 for years to come, as they try to wrap their heads around the whole 11 debacle. Their most reasonable transition strategy is surely to hold off until their hand is forced.

So, no, it isn't a happy birthday for Windows 11. But let's face it, Windows is just an operating system. Your needs for that should be robustly assessed and decisions made. Business users should go with the Microsoft flow. For others, it might be time to consider desktop Linux. ■

PC BUILDER

System News

Computex is one of Mark Williams' favourite shows. While light on reveals this year, it still didn't disappoint.

Mark Williams
Mark is an IT professional with a strong interest in voiding warranties.

Normally an annual fountain of revelations for new PC product announcements and technology showcases, Computex 2022 was unfortunately little bit of a fizzer, with not much revealed or shown off during the, yet again, online-only digital show, as COVID continues to strangle live shows and events. Next year should see a return to normality though, as Computex returns to a live show.

This year there was only one kid on the block to talk about, and that's AMD. Nvidia was in attendance but only showcased its work in the server space with AI research, a few more games that will soon support ray tracing and DLSS, and a new Nvidia Reflex-equipped Asus ROG Swift 500Hz monitor. Aside from the thirty second monitor announcement it was all rather ho-hum.

AMD, on the other hand, with the keynote speech, had lots to announce and show off. Kicking things off was the announcement of a new APU codenamed Mendocino. This is essentially the same APU as what's found in the highly praised Steam Deck console, but scaled up for entry-level laptop usage. It uses old Zen 2 cores paired with AMD's latest RDNA2 GPU cores.

Following this was the official reveal of the Ryzen 7000 CPU series based on AMD's new Zen 4 architecture. Seated in a new LGA1718 AM5 socket (a notable swap away from PGA), Ryzen 7000 will, at a chiplet level, look like Ryzen 5000 CPUs in that there'll be up to two Core Complex Dies (CCD), each housing up to eight CPU cores each for a maximum of sixteen cores plus an IO die (IOD) that ties those CCDs, the DDR5 system memory and other IO links together and to the rest of the system.

Looking closer, those CCDs will be made on TSMC's new N5 node while the IOD will be made on TSMC's N6 node, which means for the first time AMD will have finally shed the last remaining vestige of its GlobalFoundries spin off contractual agreements, which saw AMD having to source 12nm IODs for AM4 from them right up to current Ryzen 5000 series parts. The exciting part of this IOD change is that AMD is finally including integrated graphics on every IOD; it's only a very small two CU RDNA2 cluster, but it'll finally give AMD some feature parity with Intel's range of processors, which have included integrated graphics for decades.

Ryzen 7000 was demonstrated running at above 5.5GHz in a game which is a very impressive clock speed jump over Zen 3 parts and will put AMD on par with Intel on the clock speed front. Then in a multithreaded test versus an Intel 12900K the Ryzen 7000 chip completed the benchmark over thirty percent faster! These chips are going to be very impressive. ■

SHOP TALK

What new technologies or products announced during Computex got you excited?

Richard, Aftershock PC:
"Ryzen 7000 is probably what I am most looking forward to (although we kind of knew about it already from the leaks). It will be great to see AMD step back up against Intel (not that they are far behind) and force some good competition for the launch of Intel's 13th Gen in the second half of the year."

Launching Q4 | "Mendocino"
Redefining the everyday laptop
6nm TSMC | 4C/8T "Zen 2" | RDNA 2 GPU
$399 to $699 mainstream notebooks
>10 hours mixed-usage battery life (Projected)
Lenovo
Ideapad 1

Expect to see AMD's new Mendocino APU in budget machines coming soon.

PIC: AMD

Market Watch

A sampling of PC systems available this month

PLE COMPUTERS SLATE RTX 3060

$1,789 | tinyurl.com/APC509PLE

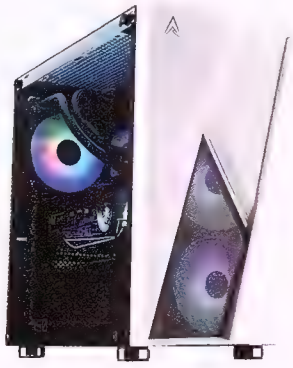
Featuring the strongest CPU of the four systems in this roundup, at this price this system is hard to beat. It even matches the GPU found in the more expensive systems.

The cherry on top is the 1TB of SSD storage; it's great having one large and fast mass storage volume to play with rather than splitting it up with some typically slower media. Another strong plus.

The RAM is acceptable at 3200MHz; it'll do the job, though Ryzen does like faster memory. Where this system lacks though is on the IO front. The motherboard is quite basic and doesn't offer a lot in the way of connectivity.

If you don't require much IO though, this is a very affordable system that offers a lot of performance for the price.

■ **CPU:** AMD Ryzen 5 5600X; **Cooler:** OEM; **Motherboard:** Gigabyte B550M-H; **Graphics:** EVGA GeForce RTX 3060 XC 12G GDDR6; **Memory:** Kingston 16GB DDR4 Fury Beast C16 3200MHz; **Storage:** Kingston NV1 1TB NVMe M.2 SSD; **Power Supply:** EVGA GD Series 600W; **Case:** Jonsbo U5 Black.



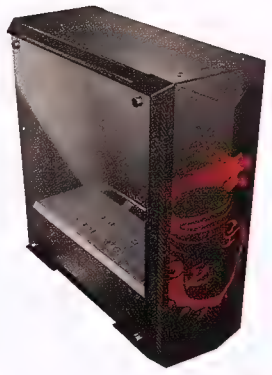
ALLIED COMPUTERS STINGER-A (MID-TIER)

$1,699 | tinyurl.com/APC509ALL

Coming in as the cheapest in the roundup, this system seems to be something of a wannabe. It wants to appear as though it's competing at this price point, but it really isn't. First, we have the 200-400MHz slower Ryzen 5 5500 paired with an older B450 motherboard, which automatically rules out PCIe 4.0 compatibility.

Then on such a low-end CPU Allied has mounted a 120mm water cooler. Neat, but a waste of money for basically no performance benefit. The power supply is also the lowest wattage of the bunch as well, meaning future upgrade paths will be hamstrung by it. Your money can be better spent elsewhere.

■ **CPU:** Ryzen 5 5500; **Cooler:** Allied Ice Cube ARGB 120mm Liquid Cooler; **Motherboard:** AMD B450 chipset-based with WiFi; **Graphics:** NVIDIA GeForce RTX 3060 12GB LHR; **Memory:** 16GB 3200MHz; **Storage:** 500GB NVME M.2 SSD, 2TB HDD; **Power Supply:** 550W; **Case:** Allied Stinger.



CPL ONLINE DRAGON

$2,199 | tinyurl.com/APC509CPL

This system is the most expensive of this issue's roundup, but it's not necessarily the best. It has a lot of SSD-based mass storage, 2.5TB of it, which is great but that's about the only thing that sets this system apart from the others.

The Ryzen 5 5600 is seated in a relatively high-end X570S motherboard, which doesn't really match the price point this system is going for. As a result, this system offers less compute than the others, but it does have a better platform to upgrade later if desired, and a plethora of additional IO options.

Best to steer clear of this one unless you can make use for all the extra IO.

■ **CPU:** AMD Ryzen 5 5600; **Cooler:** OEM; **Motherboard:** MSI MAG X570S Tomahawk Max WIFI; **Graphics:** MSI Radeon RX 6600 Mech 2X 8GB; **Memory:** Crucial Ballistix RGB 16GB DDR4 3200MHz CL16; **Storage:** Crucial BX500 2TB 2.5in SATA3 SSD, Crucial P2 500GB M.2 NVMe PCIe SSD; **Power Supply:** MSI MPG A650GF 650W; **Case:** MSI MPG Gungnir 100D.

AFTERSHOCK PC HYPERGATE - LITE

$2,050 | tinyurl.com/APC509AFT

Coming in a tad cheaper than the CPL system this rig is a bit more sensible. With the same Ryzen 5 5600 CPU, it's mated with a much more reasonable B550 motherboard to keep costs down. The graphics card is also a little bit more powerful, too, which is nice. The only real setback of this system is the 1TB HDD, which will make for some slow access times.

Happily, the RAM is rated at 3600MHz, which Ryzen CPUs like in order to achieve the best performance. A nice choice for those wanting a good return on investment.

■ **CPU:** AMD Ryzen 5 5600; **Cooler:** Aftershock M-40 Frost; **Motherboard:** Gigabyte B550 Gaming X V2; **Graphics:** Gigabyte RTX 3060 Eagle OC - 12GB – V2; **Memory:** 16GB Kingston Fury Beast Black 3600MHz; **Storage:** 512GB Samsung Gen4 M.2 NVME SSD, 1TB Western Digital Blue HDD; **Power Supply:** 650W Antec EA650G; **Case:** Nzxt H7.

PC BUILDER

Blueprints

Value- and performance-driven hypothetical builds

"The Intel system also benefits from a new B660 motherboard from Gigabyte. This change was made to mitigate the overall price hike created by upgrading our GPU."

BUDGET

A perfect balance between price and peformance.

Wow! Our Intel system looks like a whole new PC. The only things staying the same are the SSD (the T-Force Cardea Graphene Z44L is still one of the best-value PCIe 4.0 drives) and the Corsair 4000D Airflow case, everything else is new. The budget Intel rig was lagging behind the AMD system with its i5-12400 chip and RTX 3050 GPU, so both have been upgraded. The CPU is now the i5-12600, which is closer to the Ryzen 5 5600X in terms of performance with a similar price, beating it in multi-core workloads and significantly in single-core performance.

The GPU has jumped up a rung in the Nvidia hierarchy with an RTX 3060 from Gigabyte, which sits beneath the RX 6600 XT in the AMD build in terms of performance. Despite the lower RRP of the 3060, the 6600 XT is currently the cheaper card to buy, with GeForce GPU prices falling slower than Radeon ones.

Unfortunately for Nvidia fans, this all means the AMD build is a very substantial $435 cheaper than the Intel equivalent all due to the graphics card cost.

The Intel system also benefits from a new B660 motherboard from Gigabyte. This change was made to mitigate the overall price hike created by upgrading our GPU; LGA-1700 motherboards are still expensive, with the new socket type not yet the norm amongst PC-builders.

We've swapped out the Intel build's memory to keep the price down. In its place is the faithful Ripjaws V 16GB kit from G.Skill. The AMD build's only major change is a new motherboard, the MSI MAG B550 Tomahawk, at $189. The final change in the Intel rig is the hard drive, a shift mimicked by the other budget build and both midrange machines. It's a simple swap from Western Digital to Seagate, with the affordable Barracuda ST4000DM004 HDD.

AMD INGREDIENTS

Part		Price
Case	Corsair 4000D Airflow	$125
PSU	550W Corsair CV550 80+ Bronze	$75
Mobo	MSI MAG B550 Tomahawk AM4 NEW	$189
CPU	AMD Ryzen 5 5600X	$279
GPU	PowerColor Radeon RX 6600 XT Fighter 8GB	$499
RAM	16GB (2 x 8GB) Corsair Vengeance LPX CL16 @ 3600MHz NEW	$109
SSD	500GB MSI Spatium M450 PCIe 4.0 M.2 SSD	$120
HDD	4TB Seagate Barracuda NEW	$125
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$1,581

INTEL INGREDIENTS

Part		Price
Case	Corsair 4000D Airflow	$125
PSU	550W Corsair CV550 80+ Bronze	$75
Mobo	Gigabyte B660-M Gaming X AX NEW	$279
CPU	Intel Core i5-12600 NEW	$349
GPU	Gigabyte Eagle OC GeForce RTX 3060 8GB NEW	$799
RAM	16GB (2 x 8GB) G.Skill Ripjaws V CL16 @ 3600MHz NEW	$105
SSD	500GB Team T-Force Cardea Graphene Z44L PCIe 4.0 M.2 SSD	$99
HDD	4TB Seagate Barracuda NEW	$125
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$2,016

"We're keeping the Ryzen 7 5800X this month, even though with the new 5800X3D and associated chips launching, the pricing is still too good to overlook. "

MID-RANGE

A game-ready machine that can also handle demanding work.

We're keeping the Ryzen 7 5800X this month, even though with the new 5800X3D and associated chips launching, the pricing is still too good to overlook. We looked at implementing one of these upgraded CPU variants to take advantage of the 3D processor's tripled L3 cache, but they are expensive for a small performance boost.

No such reduction for the i7-12700F processor, but also a great deal is the EVGA SuperNova GA power supply in the Intel build, currently at $139. The Nzxt PSU in the AMD system has gone up, though, so we swapped it out for the SuperNova G5.

While it might not have a cheaper CPU, the Intel build does see some small discounts; the DDR4 version of the Asus Prime Z690-P is still $299, which is an excellent deal. Both machines also get a minor saving by swapping over to the Seagate Constellation ES we brought back for the budget builds.

The Intel build gets a new cooler, the Aquafusion 240 ARGB from Enermax, a dual-fan AIO cooler with slick addressable RGB lighting on the fan casings and pump block. It replaces a Corsair liquid cooler, which was no longer on sale, while the price of the Raijintek Orcus cooler in the AMD system held steady.

The midrange AMD build joins its budget sibling with an XFX Speedster GPU, the SWFT319 RX 6800 XT. The RTX 3070 is closer to its original RRP than ever, with a Gigabyte Eagle OC model here to match the one in the budget Intel machine.

There wasn't much else to change, as we're leaving both SSDs in place. The AMD steals the RAM of the Intel build though, since Corsair's Vengeance RGB RT is currently a great-value 32GB kit available at 3600MHz with RGB lighting unless you want to brave lesser-known brands.

AMD INGREDIENTS

Part		Price
Case	Lian Li PC-011-Dynamic	$209
PSU	750W EVGA SuperNOVA 750 G5 80+ Gold NEW	$139
Mobo	Gigabyte X570 Gaming X	$289
CPU	AMD Ryzen 7 5800X	$499
Cooler	Corsair iCue H100i RGB Pro XT 240mm	$169
GPU	XFX Speedster SWFT319 Radeon RX 6800 XT 16GB NEW	$1,249
RAM	32GB (2 x 16GB) Corsair Vengeance RGB RT CL16 @ 3600MHz NEW	$279
SSD	500GB Samsung 980 Pro NVME M.2 PCIe 4.0 SSD	$159
HDD	4TB Seagate Barracuda NEW	$125
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$3,177

INTEL INGREDIENTS

Part		Price
Case	Lian Li PC-011-Dynamic	$209
PSU	750W EVGA SuperNOVA 750 GA 80+ Gold	$139
Mobo	Asus Prime Z690-P LGA 1700	$299
CPU	Intel Core i7-12700F	$469
Cooler	Corsair iCue H100i RGB Pro XT 240mm	$169
GPU	Gigabyte Eagle OC GeForce RTX 3070 8GB NEW	$849
RAM	32GB (2 x 16GB) Corsair Vengeance RGB RT CL16 @ 3600MHz	$279
SSD	500GB Corsair Force MP600 M.2 PCIe 4.0	$148
HDD	4TB Seagate Barracuda NEW	$125
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$2,746

"The hefty cost of the RTX 3090 has been offset by a downward trend in the price of DDR5 memory, as the new RAM standard slowly penetrates the market."

TURBO

The maximum PC.

We're going for a small but important upgrade to both our Turbo systems this issue, with a step up from 80+ Gold efficiency rating on both power supplies to 80+ Platinum since the midrange systems are already sporting Gold PSUs. That means a new EVGA SuperNova P6 for the AMD build, while we're sticking with Corsair and upgrading to the HX850 in the Intel PC. Both are fully modular with an 850W power rating, which should only drop slightly below 90 percent efficiency at maximum load.

The Aorus Elite WiFi motherboard supporting our AMD system is still well priced, so we left it here. A sale of almost a third off the Asus Prime Z690-A DDR5 saw us swap out the other machine's motherboard, though, keeping DDR5 support for our 12th-gen Intel processor for just $399; a steal for a DDR5 board right now.

A slight price drop in the processor department saw us shave more than $20 off the AMD turbo build and $10 from the Intel machine.

Last month's Asrock's Phantom Gaming D edition of the RX 6900 XT is down to an incredible price of just $1,699. No such reductions on the RTX 3090; last issue's EVGA FTW3 card is up in price, so we swapped over to our third Gigabyte GPU of the month in the Intel system to keep the price level.

The hefty cost of the RTX 3090 has been offset by a downward trend in the price of DDR5 memory, as the new RAM standard slowly penetrates the market. The 2x 32GB Corsair Vengeance kit we added last month is cheaper. Lastly, the SSDs featured in last issue's Turbo builds have gone up, so we got two new ones; the Gigabyte Aorus Gen4 7000s and XPG Gammix S70. Both should be capable of that crisp 7,000MB/s sequential read speed that we've come to expect from PCIe 4.0 drives.

AMD INGREDIENTS

Part		Price
Case	Phanteks Enthoo Pro 2 Tempered Glass	$220
PSU	850W EVGA SuperNova P6 80+ Platinum NEW	$179
Mobo	Gigabyte X570 Aorus Elite WiFi	$345
CPU	AMD Ryzen 9 5950X	$799
Cooler	Nzxt Kraken X73 360mm	$239
GPU	Asrock Radeon RX 6900 XT Phantom Gaming D 16GB	$1,699
RAM	64GB (2 x 32GB) G.Skill Trident Z Neo DDR4 @ 4000MHz CL18	$399
SSD	1TB Gigabyte Aorus Gen4 7000s M.2 PCIe 4.0 NEW	$279
HDD	6TB WD Blue 5400 HDD	$195
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$4,414

INTEL INGREDIENTS

Part		Price
Case	Phanteks Enthoo Pro 2 Tempered Glass	$220
PSU	850W Corsair HX850 80+ Platinum NEW	$259
Mobo	Asus Prime Z690-A LGA 1700 NEW	$399
CPU	Intel Core i9-12900K	$819
Cooler	MSI MAG CoreLiquid 360R V2 360mm	$179
GPU	Gigabyte GeForce RTX 3090 Gaming OC 24GB NEW	$2,499
RAM	64GB (2 x 32GB) Corsair Vengeance DDR5 @ 5200MHz	$729
SSD	1TB Gammix Gaming S70 M.2 PCIe 4.0 SSD NEW	$239
HDD	6TB WD Blue 5400 HDD	$195
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$5,598

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QUICK TIPS

The problem solvers

The APC team field problems across the spectrum of devices and software. Learn a new trick or fix you can use.

NAS upgrade query

I'm looking at buying or building a NAS. In the past, I set up and used WD Reds in a five-disk Synology (DS1518+), configured in a Synology RAID setup. I was happy, but that was six years ago, and the technology has changed a lot. It would be great if you could do a custom NAS build or a comparison shootout between prebuilt units – actually, both would be ideal.

"I set up and used WD Reds in a five-disk Synology (DS1518+), configured in a Synology RAID setup. I was happy, but that was six years ago, and the technology has changed a lot."

I need a solution that provides scalability, reliability, and easy usability, especially for unskilled users. This would be for personal data storage and backup and not for an enterprise application, however, I would still desire good throughput speeds.

Would spinning disks still be the way to go? SATA SSDs? Or is it possible to make an ultra-small form factor using M.2 SSDs?
Jack Jordan

APC responds: The simplest solution would be to stick with what you know and upgrade to a new Synology. That's because components for low-powered self-build models are incredibly hard to source right now – mini-ITX motherboards sporting embedded low-powered Pentium and Celeron chips, such as those showcased by Asrock (**www.asrock.com/mb/index.asp#Intel CPU**) are near-impossible to find, and that's before you go hunting for a suitable chassis to house them in. Proprietary models such as those offered by Synology, QNAP, and Asustor are optimised for NAS use, so you'll have more robust RAID support, for example. For a closer look at all available Synology models, search through its NAS selector tool (**www.synology.com/support/nas_selector**) to see which models it recommends for your use.

When looking for comparisons with your old NAS, one particular model caught our eye: the $1,199, five-bay Synology DS1520+. Launched in 2020, it's powered by a modern Gemini Lake Refresh CPU (the Celeron J4125) along with 8GB RAM. Connectivity is handled with no fewer than four 1Gbps LAN ports (supporting link aggregation to maximise throughput), plus two USB 3.2 Gen 1 ports and two eSATA ports for attaching external devices. That may be overkill, in which case, the lower-spec'd DS420+ is $300 cheaper. It's powered by an older Celeron J4025 CPU, 2GB RAM (expandable to 6GB), two 1Gbps LAN ports, and four drive bays instead of five.

This leads neatly to your final question about which disks to choose. Spinning disks remain the most cost-effective and reliable storage medium, but both DS420+ and DS1520+ models also come with two NVMe slots that allow you to add NVMe SSD drives as a cache to boost overall performance.

Wireless HDMI?

In an earlier issue Gary Lavery asked if Microsoft could create virtual TPM 2.0 functionality to allow Windows 11 to run on older hardware. You responded that if this were possible, it would have already happened. I'd like to point out that it is possible but the reason it hasn't happened – and won't happen – is because Microsoft is responsible for the code requiring the TPM 2.0. However, I'm grateful for the registry workaround *APC* supplied in his answer.

Also, in the following issue, Gary Dent inquired how to hide a laptop or computer components behind the TV mounted on the wall in his kitchen. There are HDMI Bluetooth adapters made by Timbootech that connect an HDMI computer output to the HDMI input on the back of the TV. The ones I saw on Amazon support 4K.
Joe Saway

APC responds: You're right Joe, but in our (admittedly weak) defense, he did point out how to virtualise a TPM 2.0 chip in Hyper-V to run Windows 11 on older hardware in his original answer, thereby insinuating it could be done.

Regarding your second suggestion, it's a good call, in theory, but there are two major stumbling blocks to consider. The first is simply price: Timbootech's options cost $130 a pop (others are even more expensive). That might be a price worth paying if you're wanting to transmit signals between rooms (say streaming from your office's PC to the big-screen TV in your den), but it's harder to justify in a scenario where a 50cm HDMI cable should suffice. The other issue with wireless HDMI is the latency of the signal – that's not necessarily a problem when streaming or performing everyday computing tasks, but gamers are likely to find the lag is too great to make gaming practical. A quick glance at the mixed reviews on Amazon confirms this to still be a major issue.

Clear event logs

I've asked previously whether it's possible to have the Windows Event Viewer cleaned of errors and warnings. I would welcome this.
Len Babin

APC responds: Simply open Event Viewer (press Win-R, type eventvwr and hit Enter), expand Windows Logs in the left-hand pane, then right-click each log and choose 'Clear Log' to delete them in turn. You'll be prompted to 'Save and Clear' or simply 'Clear' the current log; choosing the former allows you to save it in a variety of formats (including .evtx, which can be loaded back into Event Viewer) should you need to refer to it later.

If you're looking to clear all event logs quickly and without fuss, then you might think a clean-up tool like CCleaner

Synology's DS1520+ isn't new but it's good.

(**www.ccleaner.com**) would come to the rescue. The fact is, despite offering a 'Windows Event Logs' option under Advanced in its custom cleaning section, the tool doesn't work with any version of Windows from 2018 onwards. Instead, press Win-R and type the following directory into the Run box before hitting Enter: %SystemRoot%\System32\Winevt\Logs\

This will take you to the folder containing those (and other) log files. They are easily identifiable by name, but remember – once deleted, you won't be able to look back on them for any troubleshooting help.

Dual-boot conundrum

I have a problem that I cannot find the answer to. My Ryzen 5950X system has two 1TB Sabrent Rocket 4.0 NVME drives, plus a Samsung 970 EVO NVME and 8TB internal Seagate HDD. Currently, Windows 10 is installed on one of the 1TB Rockets. I wiped out everything on the second 1TB Rocket, planning to install Windows 11 on it in a dual-boot configuration while I dip my toes in and see if any of the applications I use have problems.

I created a USB flash drive and have installed Windows a million times, so am pretty familiar with the standard procedure. When the install got up to the point of copying the files over, I got an error: 'Windows Could Not Prepare the Computer to Boot Into the Next Phase of Installation'. I have tried to troubleshoot this message, tried new boot media, created install partitions to copy the files to with diskpart, formatted these from the command prompt while installing, and so on.

Once, I got slightly further before it bombed out with the same error as before. I've thought about removing all the drives except the one Sabrent Rocket I want Windows 11 on. I've also considered partitioning the Windows 10 drive and trying to install Windows 11 on the same physical disk, but it feels more and more like I'll have to just remove the drives, install Windows 11 and then live without being able to dual boot. Any advice?
Shawn Rakestraw

APC responds: By the time we spoke to Shawn, he'd decided to forego dual boot by simply swapping out the Windows 10 NVME drive for the Windows 11 one. His only reason for pursuing the dual-boot option had been the need for a fallback if a critical program proved incompatible with the new OS. That fear proved unfounded, so he was able to work around the problem.

The error message Shawn encountered could point to some form of corruption or issue with the EFI system partition. This partition is where key files are stored for booting installed operating systems, loading required device drivers for hardware used by firmware at boot time, and any programs designed to run before the OS is loaded.

Windows setup can also get confused if there are multiple drives connected to your system – you could try disconnecting all drives except those you need: your Windows 10 drive, the drive containing your EFI system partition, and the drive you plan to install Windows 11 on. With luck, that should get it over the finish line. If it works, reconnect your other drives and then carry on just as before.

To find out more about your EFI, its location, and what boot entries it contains – download the free version of Disk Genius (**www.diskgenius.com**). After opening the program, examine the list of drives and partitions in the left-hand pane to find the one marked ESP, which is your EFI system partition. If more than one ESP exists, choose Tools > Set UEFI Boot Entries to see what boot entries are stored in your BIOS/UEFI and, crucially, where they point to – the Disk and Partition entries should match the EFI in use.

Another option to consider would be to install the second operating system completely independently of the first as Shawn did, then reconnect both drives. From here, open Tools > Set UEFI Boot Entries in Disk Genius and you'll see each OS now loads from its own dedicated EFI system partition. They will both be listed as 'Windows Boot Manager' so it's wise to take the time to rename them to Windows 10 and Windows 11 before clicking 'Save current boot entry' each time to write the changes to your UEFI.

From here, you can switch between them using your UEFI/BIOS's own boot men – first, navigate to the UEFI setup utility's Boot section to choose which drive you want to boot from by default – typically the latest version of Windows (so Windows 11 in this case). Then, should you want to boot to your older operating system, make a note of the key required to access your UEFI boot menu when you first start your PC – F11 or F12 is a common keypress. Press this, then select Windows 10 from the menu to boot to that instead. ■

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WINDOWS

Advanced Win11 tips: Command Prompt

Nick Peers dives into the deep end of making Windows behave like you want it to.

■ Any Windows PC will do. Windows 10 release 20H1 (or later) to use the Windows Terminal; otherwise, tips should all work in the old Command Prompt console.

Once upon a time, Microsoft's operating system, MS-DOS, was solely based on the Command Prompt. It remained a fundamental part of early versions of Windows but, these days, you have to dig deep to find it. Not only has it been supplanted by the more user-friendly Windows desktop, it's not even the only command-line shell available. In addition to adding support for Linux, Microsoft has also unveiled PowerShell. Despite this, however, the Command Prompt remains a valuable tool in anyone's armoury.

For the purposes of this tutorial, we're going to focus on using the Command Prompt in Windows itself to examine your system, perform key checks and fix various problems. Even if you prefer to use PowerShell, you can still read along, because PowerShell supports everything in the Command Promp – and then some. We'll examine its unique tools in more depth in a future issue, but by focusing on the Command Prompt now, you can ensure you have all the fundamentals should you need to get to those essential troubleshooting tools.

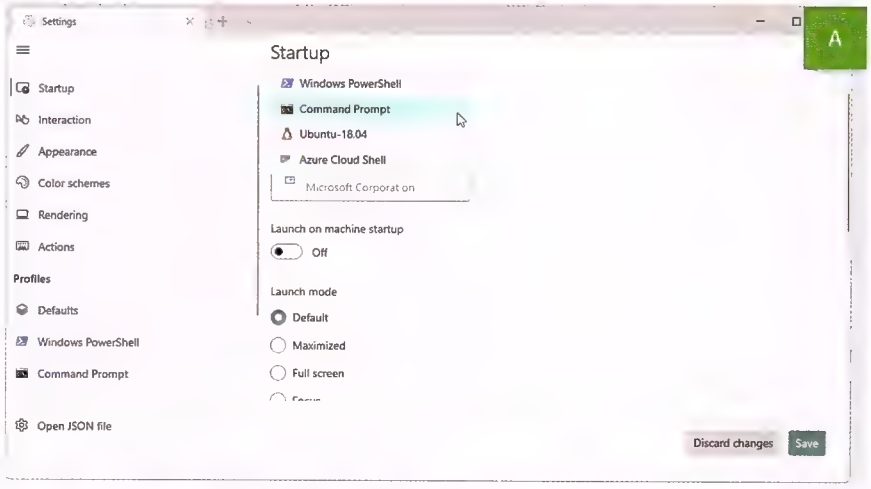
Choose your console

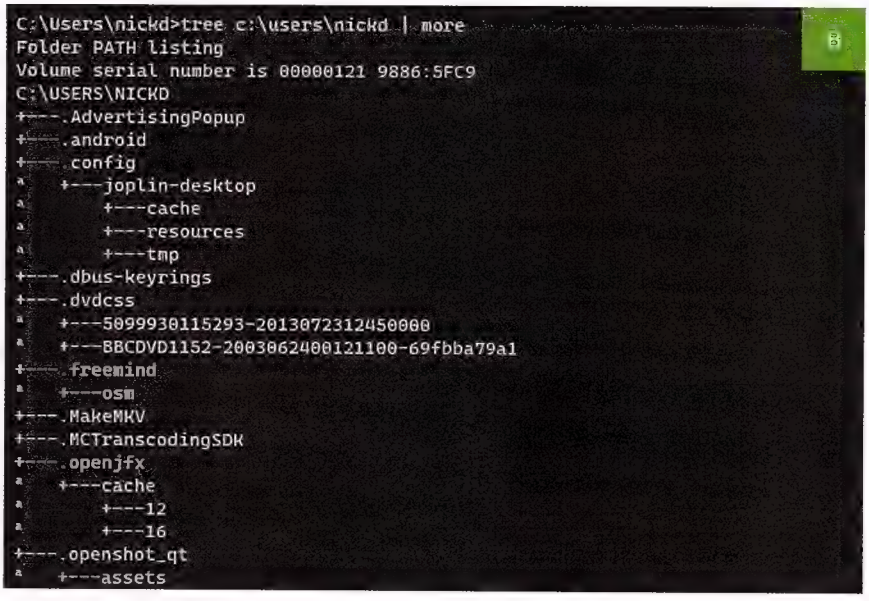
While the Command Prompt retains its own dedicated console (type 'cmd' into the Search box, then click 'Run as administrator' to launch it), you can also access it through the new Windows Terminal application by right-clicking the Start button and choosing 'Windows Terminal (Admin)'.

Windows Terminal works with all command-line tools in Windows, but creates a PowerShell instance by default. Click the down arrow next to its tab and you'll reveal options to open further tabs using other shells, including Command Prompt (press Ctrl-Shift-2 as a shortcut) and any Linux shells you've installed as part of the Windows Subsystem for Linux.

The good news is that you can choose which shell is the default when opening Windows Terminal: click 'Open Settings' followed by the 'Default profile' dropdown under Startup to select Command Prompt from the list **[Image A]**. Click Save and the next time you open Windows Terminal (or a new tab via the + button), it will open a Command Prompt console by default.

The Command Prompt console is also accessible outside of Windows via the Advanced Start Options menu, typically when Windows fails to boot. Should you need to reboot to it from Windows for a spot of deep-seated troubleshooting, type shutdown /r /o into Windows Terminal and hit Enter.





Navigate your hard drive

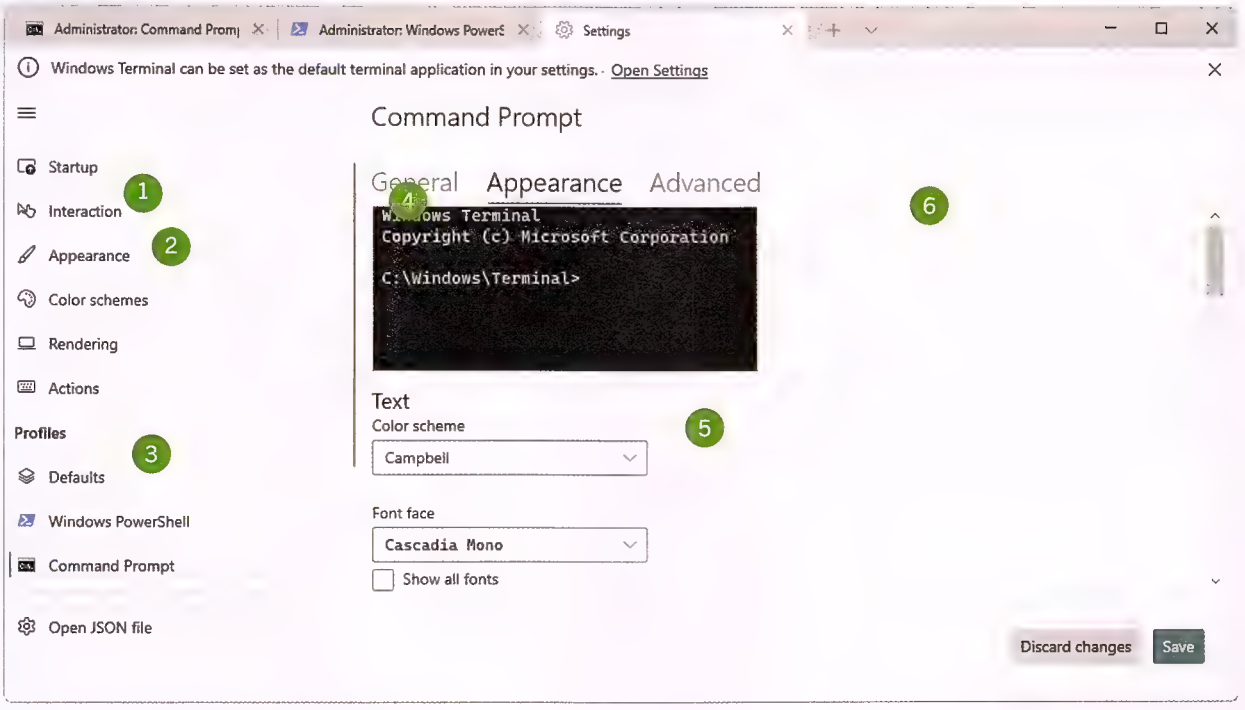
By default, you're placed in your own user directory after opening Windows Terminal. Start by typing dir and hit Enter for a list of all the files and folders in the current directory. Add the '/a' flag followed by an attribute to change what's shown, including '/a:h' for hidden files, '/a:r' for read-only files, '/a:d' for directories, and '/a:h' for system files.

Want to visualise how a specific directory is broken down? Use the 'tree' command on the current directory or specify a directory, such as tree c:/windows/system32 **[Image B]**.

How about moving between directories? Unsurprisingly, the standard 'cd' command is used here, using the following syntax:

- cd "<full path>" jump to that specific directory within the current drive (eg, cd "C:\Windows\System32")
- cd <variable> substitute a directory with an environment variable (cd %appdata%)
- cd <directory> enter the named directory inside the currently selected folder (cd documents)
- cd .. – move up a level

If you want to switch to a different



CUSTOMISE WINDOWS TERMINAL

1. STARTUP
Select this to set what happens when opening Windows Terminal. Choose the Command Prompt under Default profile to launch that by default.

2. INTERACTION
Flick the 'Automatically copy selection to clipboard' switch to On to speed up copy and paste using the Windows Terminal. If copying rectangular selections, flick 'Remove trailing white-space...' to On too.

3. ACTIONS
Use this dialog to view and change existing keyboard shortcuts, plus set new ones from dozens of available commands and options.

4. GENERAL TAB
The options here include allowing you to rename the Command Prompt tab. You can also set a different starting directory instead of your personal user folder.

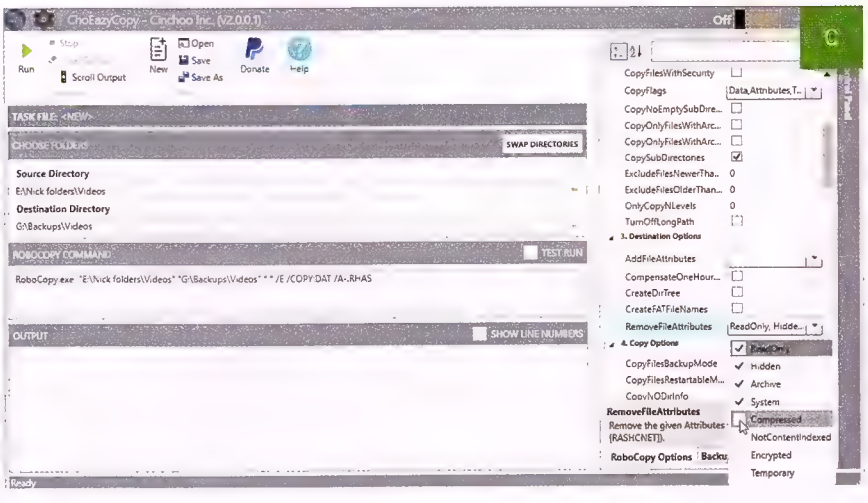
5. APPEARANCE TAB
Change the colour scheme, font (family, weight, and size), cursor type, and even set a background, among other options.

6. ADVANCED TAB
Useful options here include setting a limit to the history of previous commands (9001 by default). You can also change the notification from a sound to a visual flash and specify when the Terminal window closes.

drive, you'll find the cd command has no effect – simply type the drive letter (such as d:) and hit Enter, then use the 'cd' command to navigate to your desired folder.

Work with files
You can manage files from the Command Prompt using: 'copy', 'move', 'rename', and 'del'. All work with individual files as well as wildcards (del *.* is the nuclear option for all files within the current folder, for example). You can manage folders too: 'md' creates a folder, while 'rmdir' removes it. If you plan to delete a folder that isn't empty, use rmdir /s <directory> to delete it and its contents.

That's useful if you're troubleshooting outside of Windows, but with File Explorer on hand most of the time, it can be overkill. That said, you might want to use Command Prompt to, say, copy all text files from a folder without touching anything else. Try copy *.txt c:txtbackup



/V. The optional /V flag verifies the copied files to ensure they've been written correctly.

Another handy feature offered by 'copy' is the ability to merge multiple files into one – this obviously only works with files that can be merged in this way, so won't work with Microsoft Word documents, but will work with text. Use the following syntax:

COMMAND PROMPT 101

What can you do with the Command Prompt? There are dozens of useful commands you can input, and we'll be showcasing the best of them in this tutorial. Before going any further, it helps to understand how commands are broken down, known as the command syntax.

There's the command itself, of course, but it's usually followed by one or more options, some compulsory (in that you must choose at least one), others optional. These options are context-sensitive – they might refer to a path or filename, as is the case with the 'recimg' command for creating a recovery image, or they may refer to various 'flags', which instruct the command to work in a specified way – for example, adding -v to a command like 'driverquery' usually tells it to output the command's results in 'verbose' or detailed mode rather than as a basic summary. Note, unlike with Linux, flags aren't case sensitive, so typing -v or -V results in the same thing.

There are many commands to learn and master – visit **https://docs.microsoft.com/en-us/windows-server/administration/windows-commands/windows-commands** for a complete list, or use the /? flag for a quick reference within Windows Terminal itself.

```
copy file1.txt+file2.txt+file3.txt newfile.txt
```

The cipher command allows you to wipe the free space in a folder by writing random data to it. Delete files first, then navigate to the folder and type:

```
cipher /w:<path>
```

Cipher can also be used, as its name implies, to encrypt and decrypt files too.

Make use of robocopy

Command Prompt is home to a powerful tool called robocopy, which among other things allows you to mirror two locations for backup purposes, a bit like RAID. All associated attributes – including date and time stamps – are preserved, but the command is packed full of filters and options that can be impossible to grasp without the relevant reference information (**https://docs.microsoft.com/en-us/windows-server/administration/windows-commands/robocopy**) to one side. Even then, one mistake could have consequences.

If you find the idea of robocopy appealing but are put off by the complexity, never fear: several GUI frontends have been developed, including the free and open-source ChoEazyCopy (**https://github.com/Cinchoo/ChoEazyCopy**). Simply select your source and destination directories, then use the options box on the right to select the various flags and options on offer. A handy robocopy command box **[Image C]** reveals what the equivalent robocopy command would be in the Command Prompt, enabling you to use ChoEazyCopy as an education tool.

Troubleshoot your PC

Let's start with the 'chkdsk' tool for checking drives for errors. Use chdsk on its own to perform a quick scan of the current drive to verify all is well, or type chkdsk d: to scan a different drive. If problems are found, use the '/r' flag (so chkdsk c: /r) to both fix problems and attempt to recover readable information from bad sectors. If the drive is in use, you'll be prompted to schedule the check for the next time you restart Windows. Press Y and reboot to have a full check performed.

Want a summary of information about your system? Use the 'systeminfo' command, which aside from the usual stuff, can reveal useful snippets like when Windows was first installed and which hotfixes have been installed **[Image D]**. It can also be used to see if your PC is capable of Hyper-V virtualisation.

Use the 'driverquery' command to get information about all the drivers on your system – software too, such as those installed by your security software and virtualisation tool. These are marked as 'File System' drivers, and if you want more information, use the -v flag for detailed information about each driver, including where its files are on your hard drive.

The -v flag produces an awful lot of information, so be sure to check the tips and tricks box to find out how to more efficiently review this, either by scrolling a page at a time or by outputting it to a text file.

Fix problems with SFC

Another well-known tool is the System File Checker and most people know that running sfc /scannow should, in theory, detect any corrupt system files and replace them with working backups. It's not always successful – if you get a message telling you that Windows Resource Protection couldn't fix all the corrupt files it found, the DISM tool is your go-to tool for getting things working again:

```
dism /Online /Cleanup-Image /ScanHealth
```

If your source image gets the all-clear, issue the following command before running 'sfc /scannow' again:

```
dism.exe /Online /Cleanup-image /Restorehealth
```

If your source is corrupt, but 'repairable', create an ISO file using the Windows Media Creation Tool, then double-click the ISO file to mount it as a virtual drive.

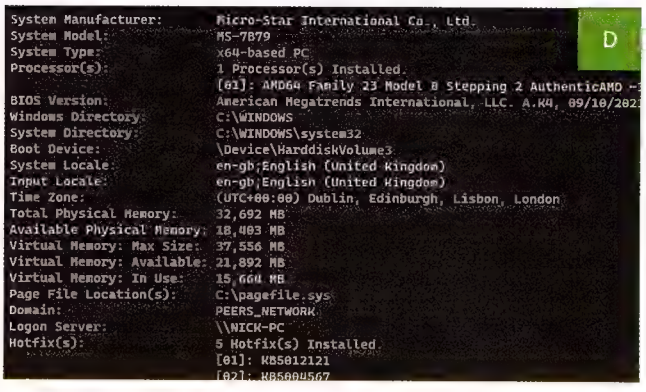
From here, open the drive in File Explorer and verify whether install.wsm or install.esd is present in the sources folder. Return to Command Prompt and type the following, substituting E with the actual drive letter and replacing 'install.wim' with 'install.esd' if applicable:

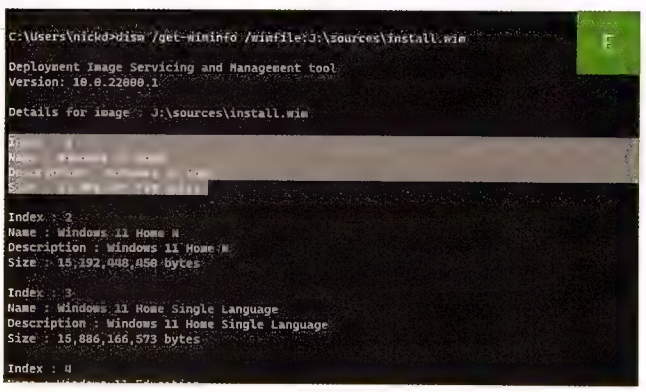
```
dism /get-wiminfo /wimfile:E:\sources\install.wim
```

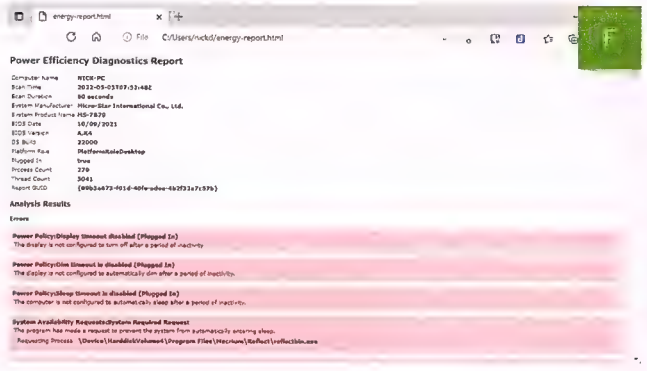
You'll see a list covering all available editions of Windows **[Image E]**, including Home (index 1) and Pro (index 6). Once you've worked out which number matches your edition of Windows, issue the following command, substituting 1 with the relevant index number:

```
dism /Online /Cleanup-Image /RestoreHealth /
Source:wim:E:\sources\install.wim:1 /limitaccess
```

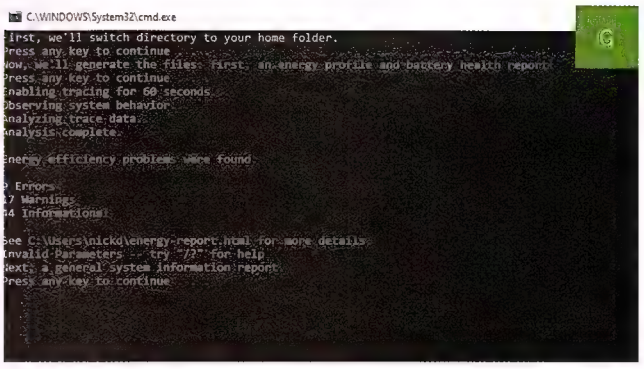
This should fix any lingering corruption, enabling you to use 'sfc /scannow' again.


D
System Manufacturer: Micro-Star International Co., Ltd.
System Model: MS-7B79
System Type: x64-based PC
Processor(s): 1 Processor(s) Installed.
[01]: AMD64 Family 23 Model 8 Stepping 2 AuthenticAMD
BIOS Version: American Megatrends International, LLC. A.K4, 09/10/202
Windows Directory: C:\WINDOWS
System Directory: C:\WINDOWS\system32
Boot Device: \Device\HarddiskVolume3
System Locale: en-gb;English (United Kingdom)
Input Locale: en-gb;English (United Kingdom)
Time Zone: (UTC+00:00) Dublin, Edinburgh, Lisbon, London
Total Physical Memory: 32,692 MB
Available Physical Memory: 18,403 MB
Virtual Memory: Max Size: 37,556 MB
Virtual Memory: Available: 21,892 MB
Virtual Memory: In Use: 15,664 MB
Page File Location(s): C:\pagefile.sys
Domain: PEERS_NETWORK
Logon Server: \\NICK-PC
Hotfix(s): 5 Hotfix(s) Installed.
[01]: KB5012121
[02]: KB5004567


E
C:\Users\nickd>dism /get-wiminfo /wimfile:J:\sources\install.wim
Deployment Image Servicing and Management tool
Version: 10.0.22000.1
Details for image : J:\sources\install.wim
Index : 2
Name : Windows 11 Home N
Description : Windows 11 Home N
Size : 15,192,048,450 bytes
Index : 3
Name : Windows 11 Home Single Language
Description : Windows 11 Home Single Language
Size : 15,886,166,573 bytes
Index : 4



F


C:\WINDOWS\System32\cmd.exe
First, we'll switch directory to your home folder.
Press any key to continue
Now, we'll generate the files: first, an energy profile and battery health report
Press any key to continue
Enabling tracing for 60 seconds
Observing system behavior
Analyzing trace data
Analysis complete.
Energy efficiency problems were found.
9 Errors
17 Warnings
14 Informational
See C:\Users\nickd\energy-report.html for more details
Invalid Parameters - try "/?" for help
Next, a general system information report
Press any key to continue

G

Examine power-related issues

The 'powercfg' command is your go-to when troubleshooting power-related problems. Start with powercfg /a for a summary of which sleep states are supported on your PC.

Next, use powercfg /h on and powercfg /h off to enable and disable hibernation. If you've disabled it because of drive space concerns, the good news is that Microsoft has optimized the file in recent years, so the hiberfil.sys is now around 40 percent the size of your installed RAM, that's a relief for those with small boot drives and 32GB of RAM. It's also possible to trim the hiberfil.sys file so it's just 20 percent of your installed RAM (powercfg /h /type reduced), but you'll need fast startup enabled.

The command can also generate detailed information – use the '/energy' flag to create a report that highlights potential energy efficiency and battery life issues **[Image F]**. Once created, a file called energy-report.html will be saved to the directory you're currently in. Before analysing it to find out why your PC won't stay asleep, however, try powercfg / lastwake, which reveals the last device to wake your computer.

Laptop users might want to try the '/ batteryreport' flag, which like /energy saves a report you can view in your web browser. This gives you a full overview of your battery's health as well as a graph showing its usage over the past 72 hours.

Troubleshoot network problems

There are other, more focused, information tools as well. Use ipconfig to get information about your local network settings – use the /all flag for more detailed information.

ipconfig can also be used to fix certain connectivity problems – use '/release' to release the IPv4 address ('/release6' works with your network's IPv6 address if applicable), and '/renew' or '/renew6' to effectively reset it. Try ipconfig /flushdns when struggling to resolve domain names over the internet.

Where more than one network interface is present (as is often the case on PCs with virtualisation software installed), you can also specify the adapter after your flag: ipconfig /renew Ethernet, for example.

Another command that can also prove useful when troubleshooting network and internet connectivity is 'ping', which can be used to verify connections between local network devices or websites. Use it in conjunction with the device name, its local IP address, web address, or remote IP address. If you ping using a domain or device name, you will also be told its IP address (such as 199.232.194.114 for our sister website, techradar.com, for example).

For a detailed route between your computer and an IP address, substitute 'ping' with tracert to see which IP addresses your connection travels through to reach its destination. The command is also handy for spotting bottlenecks that are slowing the connection.

Want to know what ports are open on your PC and where they point to? Then why not use the 'netstat' command. Try netstat -b while running as an administrator if you want to find out more about which program or process has opened which port. It's a slow process, but worth it if you're wondering why a particular port is open.

Working with batch files

While PowerShell is the recommended shell for automation, you can still use batch files in Command Prompt to process a sequence of repetitive commands quickly and easily. Create them in any text editor – place each command with its options on a separate line and when you come to save the file, make sure it's given a .cmd extension instead of .txt.

Command Prompt includes several commands specifically designed for using in batch scripts. Let's start with 'pause', which when inserted into your script results in a 'Press any key to continue' message. The 'echo' command allows you to display text on-screen, while inserting '@echo off' at the top of your batch file prevents the commands from appearing on-screen in Windows Terminal as they're run.

Other useful commands include 'call', which allows you to call a second batch file from within the first, plus several commands that provide interactivity to the end-user in the form of choices: 'choice', 'set', 'if' and 'goto'.

Batch files can be run by either double-clicking them in File Explorer or right-clicking them and choosing 'Run as administrator' to run with elevated privileges. You'll see the traditional Command Prompt window appear, and it disappears when the script completes. ■

COMMAND PROMPT TIPS AND TRICKS

The Windows Terminal is packed with time-saving features, some of which made their way into the default Command Prompt console. When using the latter, you should find QuickEdit Mode is enabled by default (if not, right-click the console bar and choose Defaults). This makes it easy to select and copy text from the console quickly using the mouse. Place the text where you wish to paste it in the console and right-click again.

Many commands generate pages and pages of data – to save you the onerous task of scrolling back up to review them, add the '| more' option onto the end of offending commands to force them to show the first page then pause – from here, press Enter to move down a line at a time, or press the spacebar to scroll through the next page. Alternatively, redirect the information to a text file with the > switch – for example, driverquery -v >drivers.txt will create the file in your current directory.

Want to clear the screen buffer and start with a fresh new 'page'? Type cls and hit Enter. Finally, use the up and down cursor keys to scroll through previous commands to speed up text entry.

WINDOWS

Run your own home server

Fancy centralising your storage for free? Nik Rawlinson explains how to turn an old PC into a fully functional Linux server.

We all use servers daily. Whether we're syncing files, streaming music or working in web apps, we rely on remote processing and centralised data storage. Indeed, much of the time we're working with data that never touches our local machines.

But a server that's owned and operated by someone else isn't always the best option. Suppliers build their infrastructure to service the needs of their business – so unless your needs just happen to coincide with their most efficient way of making money, the services you use won't be perfectly tailored to your requirements.

There is an alternative: run your own server at home. The idea may seem outdated – the Windows Home Server platform came and went many years ago. But it's as practical as ever to repurpose an old PC that would otherwise be gathering dust, and you don't need a server-specific version of Windows: a Linux distribution is arguably a better option, and not just because it's free.

Here, we'll show you how to build and configure a home server using Ubuntu 22.04. You can use more or less any PC or laptop: all you need is a dual-core x86 processor, 4GB or more of memory, at least 25GB of hard drive space (note that the drive will be wiped during installation) and a VGA or higher-resolution display. If you don't have a suitable computer, check eBay, Gumtree or second-hand stores.

Server vs desktop software

Ubuntu is offered in Desktop and Server variants, and while the name might point you towards the latter, there are good reasons for sticking with the Desktop edition.

One of them is the fact that the Server build installs without a graphical interface. This won't be a problem most of the time, as you'll largely be interacting with your server over the network. However, a GUI is a useful option to have when you want to make quick changes, or if you aren't comfortable administering Linux at the command prompt.

For this reason we'll be using Ubuntu Desktop, but if you do choose the Server package you can also perform many common administrative tasks through a browser using Cockpit, which we'll be installing just as soon as the OS is up and running.

Install Ubuntu Desktop

The first step is to download an Ubuntu Desktop installation image from **ubuntu.com/download**. You'll also need a way to write it to a removable medium such as a USB flash drive: we'll use Balena Etcher (**balena.io/etcher**) for this. Once you've downloaded and installed the program, click "Select image", then navigate to the Ubuntu ISO file you just downloaded. Click "Select drive" and pick your USB drive; finally, click Flash. This wipes your USB flash drive, makes it bootable, and copies across the Ubuntu installer. When it's finished, unplug the flash drive and move it to the machine you want to set up as your home server.

The next step is to boot from the flash drive. Sometimes you can do this by pressing a keyboard shortcut when the computer first powers on, but you might need to make a change to your computer's BIOS or UEFI settings – check your documentation, online help or web forums.

Once the Ubuntu installer has booted, click the option to install the operating system and work your way through the wizard. Make a particular note of the username and computer name you specify as part of the installation process, as these will be needed later on in the setup process. When the installation completes, reboot again and log in using your new credentials.

Install Cockpit

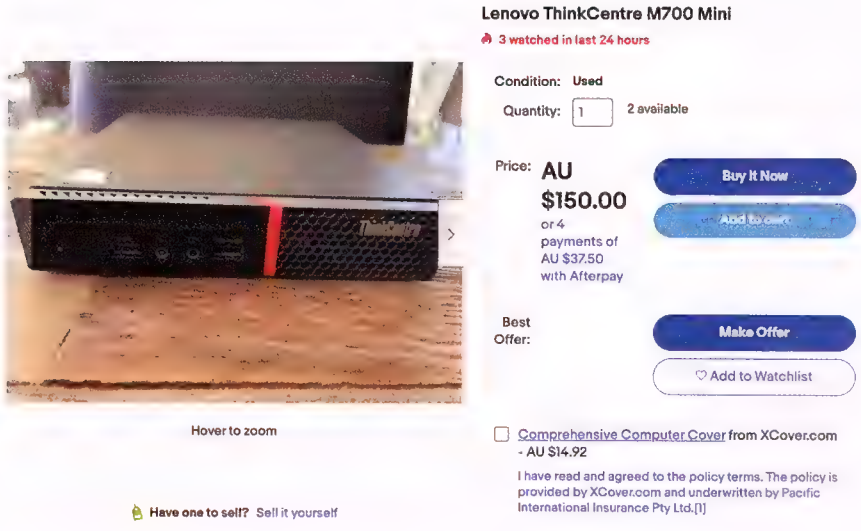
Once your server is running, you ideally want to be able to administer it remotely. That way, you can run it "headless" – without a monitor, keyboard or mouse attached – and even hide it away beneath a desk or in a cupboard.

The Cockpit tool is a big help here: it makes your server accessible through a web browser, so you can administer it from any other device on your network. To install it, launch Ubuntu Software, which you'll find in the Ubuntu sidebar, and search for Cockpit. Click Install.

Once Cockpit has finished installing, we suggest you give your server a static IP address on your network, so you'll always know where to find it. To do this, open Settings by clicking the nine dots at the bottom of the sidebar, followed by Settings. Now click Wi-Fi in the sidebar, then click the cog beside the name of your active network connection.

Click the IPv4 tab and, in the IPv4 Method section, select Manual. Type the address, Netmask and Gateway (router address) you want to use in the Addresses boxes that appear, then click Apply.

With this done, it's time to test that Cockpit is working. Move to any other machine on your home network, open a browser, and point it at your server's IP address, suffixed by ":9090". In our case, our server is located at 10.0.0.46, so we


Lenovo ThinkCentre M700 Mini
3 watched in last 24 hours
Condition: Used
Quantity: 1
2 available
Price: AU $150.00
or 4 payments of AU $37.50 with Afterpay
Buy It Now
Add to cart
Best Offer:
Make Offer
Add to Watchlist
Comprehensive Computer Cover from XCover.com - AU $14.92
I have read and agreed to the policy terms. The policy is provided by XCover.com and underwritten by Pacific International Insurance Pty Ltd.[1]
Hover to zoom
Have one to sell? Sell it yourself

You can pick up a suitable second-hand PC for peanuts online.

can access Cockpit by entering "10.0.0.46:9090" in the browser's address bar.

Log in using the username and password you specified when installing Ubuntu, and you can start exploring the various options in the sidebar. As you'll see, you can easily add new users, set up new services and update software through the interface. By clicking Terminal, you can also access the command prompt.

Enable remote access

Although you can interact with the Terminal through Cockpit, it's neater to access it via SSH (Secure Shell), which can be opened directly from the Windows command prompt.

First, you need to enable the Ubuntu SSH service. If you're sitting in front of your new server, open a new Terminal window with Ctrl-Alt-T. If you're accessing it through a browser, log in to Cockpit and click Terminal in the sidebar. Now make sure that the catalogue of installable files packages is up to date by entering:

```
sudo apt update
```

When prompted, enter your password. When the software catalogue has finished updating, type:

```
sudo apt install -y openssh-server
```

and press Return. This will install and enable the SSH server in a single operation. However, you still won't be able to log in remotely because, by default, the Ubuntu firewall blocks SSH traffic. To let it through, type:

```
sudo ufw allow ssh
```

and press Return. The server should now be running and accessible; to test it, go to your Windows machine, open a new command prompt, and type:

```
ssh [username]@[ip address]
```

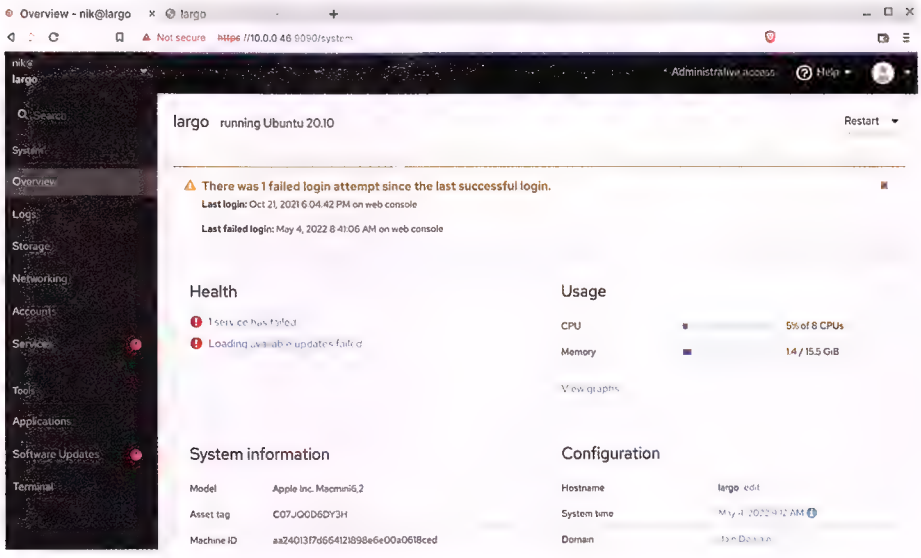
Of course, replace [username] with the username for your account on the server, and [ip address] with the server's IP address as configured earlier – so in our case, we'd type:

```
ssh nik@10.0.0.46
```

You'll be asked if you want to add the SSH fingerprint to the list of recognised hosts. Confirm that you do, then enter your server password.

Set up file sharing

One of the core functions of a home server is storing files. This lets you keep your data in a central location, where it can be accessed from any computer on the network and shared among family members.



Cockpit lets you administer your server through a browser.

To set this up on your Ubuntu machine, you'll need to install and enable the Samba package, which enables Windows-compatible file sharing. Again, this is done from the command line, so log in using SSH or open a Terminal window. Now install Samba with the following command:

```
sudo apt install samba
```

When the Samba server has finished installing, you need to give it a place to store your shared files. To do this, we'll create a folder called "shared" with the command:

```
mkdir shared
```

You now need to tell Ubuntu where this folder is and what permissions you want to grant to anyone who tries to connect. We can do this by editing the Samba configuration file using the nano text editor. Enter the following command:

```
sudo nano /etc/samba/smb.conf
```

A file should open that's mostly filled with comments. Move your cursor down to the bottom of the file and append the following lines, replacing [username] with your Ubuntu username:

```
[shared]
  path = /home/[username]/shared
  read only = no
  browsable = yes
  comment = Shared files on server
```

Press Ctrl-x to quit nano; when asked if you want to save your changes, press Y, then press Return to overwrite the existing configuration file.

You'll need to restart the Samba service for your changes to take effect: do this using the following command:

```
sudo service smbd restart
```

Just as with SSH, you also need to add Samba to the list of services for which traffic is allowed to pass through the firewall:

```
sudo ufw allow samba
```

The last step is to grant access to any user who needs to access the shared drive, starting with yourself, by typing the following, again replacing [username] with your server username:

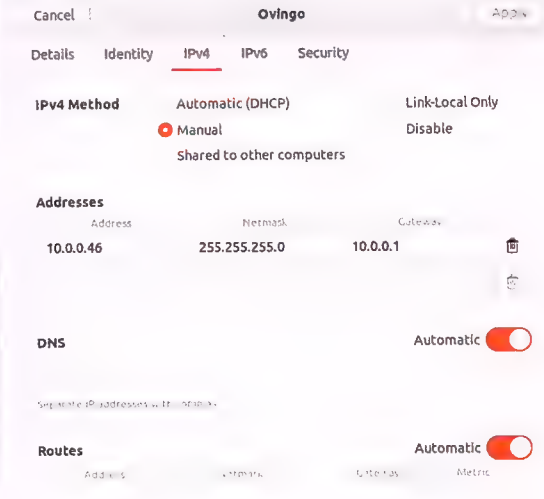
```
sudo smbpasswd -a [username]
```

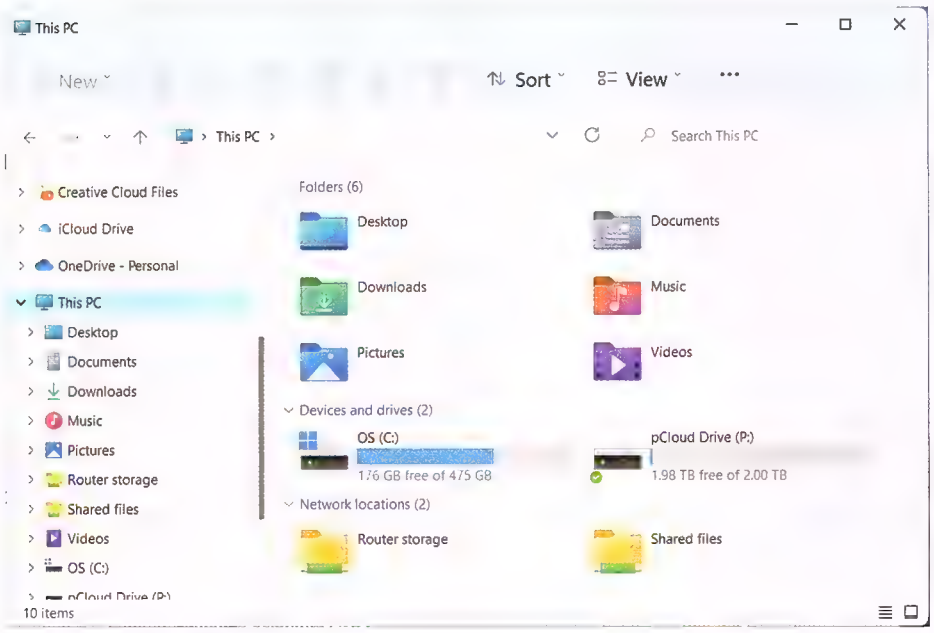
Ubuntu will ask you to enter a Samba password, then repeat it for confirmation. It doesn't need to be the same as the password you use to log on to the server, but whatever you choose, make sure you remember it (and enter it correctly both times).

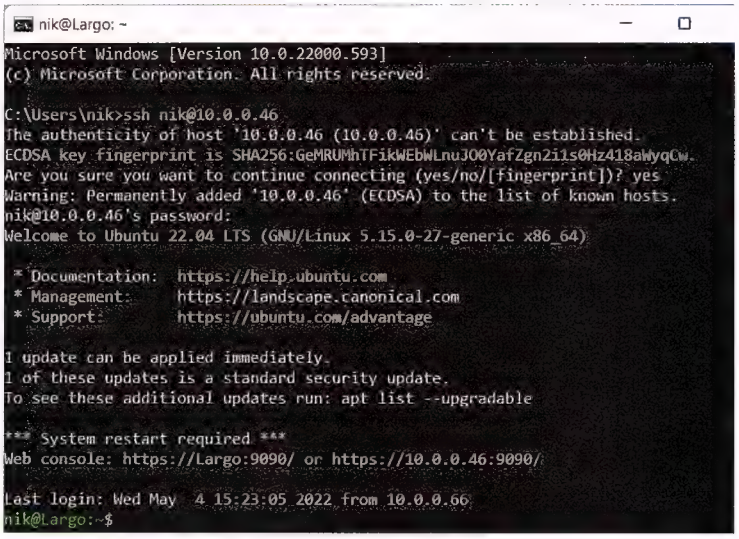
With all this done, you should now be able to connect to the shared folder from a Windows machine, and for easy access we recommend you map a drive to it.

To do so, click "This PC" in a File Explorer window, then right-click

A static IP address makes your server easy to find on the network.






nik@Largo: ~
Microsoft Windows [Version 10.0.22000.593]
(c) Microsoft Corporation. All rights reserved.
C:\Users\nik>ssh nik@10.0.0.46
The authenticity of host '10.0.0.46 (10.0.0.46)' can't be established.
ECDSA key fingerprint is SHA256:GeMRUMhTFikWEbWLnuJO0YafZgn2i1s0Hz418aWyqCw.
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '10.0.0.46' (ECDSA) to the list of known hosts.
nik@10.0.0.46's password:
Welcome to Ubuntu 22.04 LTS (GNU/Linux 5.15.0-27-generic x86_64)
* Documentation: https://help.ubuntu.com
* Management: https://landscape.canonical.com
* Support: https://ubuntu.com/advantage
1 update can be applied immediately.
1 of these updates is a standard security update.
To see these additional updates run: apt list --upgradable
*** System restart required ***
Web console: https://Largo:9090/ or https://10.0.0.46:9090/
Last login: Wed May 4 15:23:05 2022 from 10.0.0.66
nik@Largo:~$

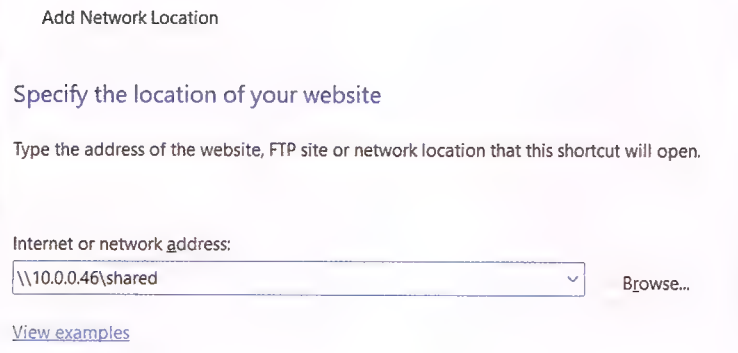
Above: When you've mapped a Samba share it's added to Windows' Network locations. **Right:** Access your server's Terminal from the command prompt.

the blank space in the main pane. On Windows 10, click "Map network drive"; on Windows 11, click "Show more options" followed by "Map network drive".

This brings up a window asking for a network address. Enter:

\\[ip address]\shared

Once again, replace [ip address] with the server's IP address. Click Next, then enter the username and password you set up on the server, and click Next. Finally, give the drive a logical name, such as "Shared files", and click Next, followed by Finish. The shared drive will now be added to the area for "Network locations" that appears when you click "This PC" in the File Explorer.


Add Network Location
Specify the location of your website
Type the address of the website, FTP site or network location that this shortcut will open.
Internet or network address:
\\10.0.0.46\shared
Browse...
View examples

Windows lets you map a Samba share to a network drive.

Enable VNC

We've seen how Cockpit lets you remotely access key administrative settings. VNC takes things further, giving you a full remote desktop that you can use to browse, configure and run apps over the network. Ubuntu comes with a built-in VNC server, but it isn't enabled by default. To switch it on, open Settings (click the nine dots at the bottom of the sidebar, followed by Settings). Now click Sharing, and click the switch on the title bar so it slides to the right and goes orange.

Next, click Remote Desktop and make sure Remote Desktop and Remote Control are both switched on. Tick the box beside Enable Legacy VNC Protocol, then click the stacked dots to the right of this and change the setting from "New connections must ask for access" to "Require a password". If you don't do this, every time you try to connect from Windows, the server will pop up an alert asking a local user to authorise it, which rather defeats the purpose of remote access.

Ubuntu will automatically set a username and password for you in the Authentication section at the bottom of the interface. Note that this password isn't the same as the one you use to log in to the server. You can click the eye icon to see what it is, and make a note of it – or change it to something you'll remember.

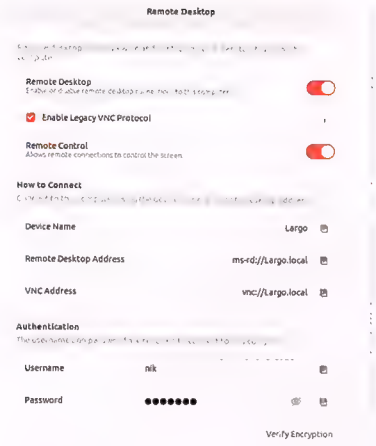
The last step is simply to make a note of the Remote Desktop Address and VNC address in the section above; you can then close the panel.

You can now view and control the server GUI from a Windows machine, or from a wide range of other devices, using a compatible VNC client. One such option is the free TightVNC client, which you can download from **tightvnc.com**.

Once you've installed the TightVNC Viewer tool, launch it and, in the Remote Host field, type the IP address or name of your server (without the vnc:// prefix), followed by a ":0" (without quotes). In our case, we named our server Largo as part of the Ubuntu installation, so we enter:

Largo.local:0

Click Connect and, when prompted, enter the password specified in the Authentication section of the Remote Desktop



Enable VNC and Remote Desktop to access the GUI from another PC.

pane in Settings. The ":0" indicates that we want to see the main screen of the server – if it were running multiple desktops, we could access these using ":1", ":2" and so forth.

An important point to note about VNC is that it works by sharing whatever is showing on the screen, but if there isn't a monitor connected then Ubuntu doesn't bother drawing a desktop, and that means VNC won't work.

If you want to run a "headless" server without a physical display, you'll need to work around this. There are a variety of software fixes that involve creating dummy displays, but the easiest solution is to buy a display emulator, a tiny dongle that plugs into your HDMI socket and makes the computer believe there's a Full HD monitor connected.

Enabling auto login

A final gotcha is that Ubuntu's default password-security settings mean that you won't normally be able to log in to your VNC server without first logging in to the server itself, and providing the right password to unlock the "keychain" of saved credentials. This is hardly convenient for a headless server, but you can get around the issue with a few simple steps.

First, open Ubuntu's Settings window and click Users. Select the user that you want to use for VNC, click "Unlock..." at the top of the screen to unlock the controls, and enter your password. Now click the switch to enable Automatic Login. From now on, your server will automatically log in to this user account each time it starts up.

Now close Settings and open "Passwords and Keys". Right-click Login at the top of the sidebar, then click Change Password. Enter your existing password to unlock the keychain. The next dialog box asks for a new password. Leave both fields blank and click Continue. When warned that your passwords will be stored without encryption, click Continue.

The next time you reboot your server, it should automatically log in to your specified user account, and allow you to control your headless server remotely via VNC.

Share your music

Before closing the server's Sharing pane, you might also want to enable Media Sharing. To do so, click the switch at the top of the window to enable sharing; your current network connection will be shown in the Networks section below. Make sure the switch beside it is slid to the right to enable sharing on that connection.

Any music you've stored in the Music folder for your user account on the server will be shared on your local network. To access it in Windows, launch Windows Media Player and it will detect the shared library. Click the library in the Media Player's sidebar to navigate its contents. ■

WHAT ELSE CAN I DO?

It's useful to have your own server for file sharing and storage, but that's not all you can do with it. Here are some other services you might consider setting up.

RUN A MEDIA SERVER

Your server can not only store video and music files, it can present them with a user-friendly front end, and stream them to web browsers and apps across your network. There are several packages to choose from: one of the best known is Plex (**plex.tv**) but popular alternatives include Emby (**emby.media**) and Jellyfin (**jellyfin.org**). Remember, though, if you're using an old repurposed PC, it might not have the horsepower to decode and stream 4K movie files.

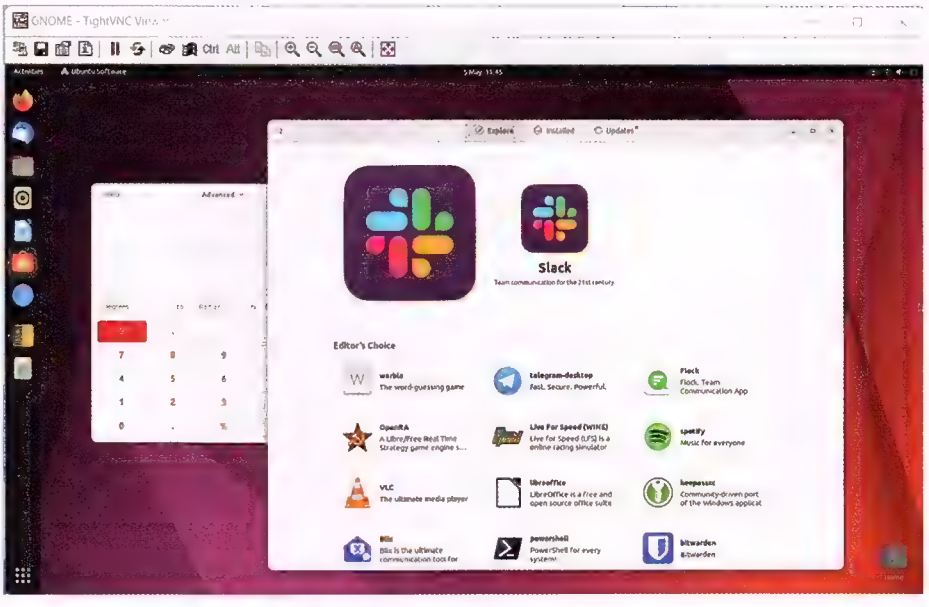
STORE YOUR BACKUPS

We all know it's a good idea to keep our computers backed up, and storing backups on a central server means they're safe if one machine suffers a hardware failure. You can use your shared storage as a backup destination for Windows' File History feature, and for Mac users it's also possible to set your server as a Time Machine repository.

HOST YOUR OWN PRIVATE CLOUD

If you're fed up of running out of space on Dropbox or Google Drive, you can configure your home server as a personal cloud service, complete with synchronisation agents for your computers and tablets. Two well-supported options are ownCloud (**owncloud.com**) and Nextcloud (**nextcloud.com**).

We wouldn't recommend this for Linux novices, however, as in both cases there are some quite technical steps involved in the installation, but documentation and community support are on hand to help you out.

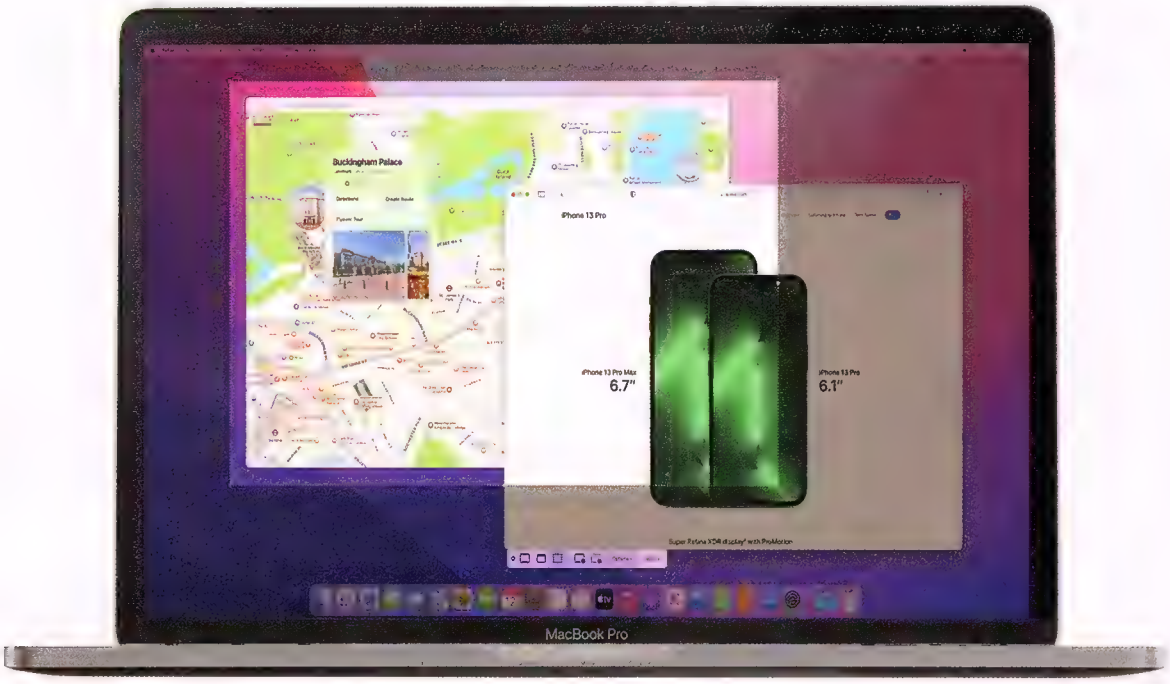


TightVNC lets you control the Ubuntu GUI from Windows remotely.

MAC OS

Master screenshots on Mac

Take quick and easy screengrabs to speed up your workflow with Alex Blake.



IT WILL TAKE
5 minutes

YOU WILL LEARN
How to capture images and videos of your Mac's screen

YOU'LL NEED
macOS 12 or later

Every now and then, you'll probably need to take a screenshot or video recording of your Mac's screen. Rather than take a blurry photo using your iPhone, you can use the built-in tools in macOS to get a crisp, clean capture instead.

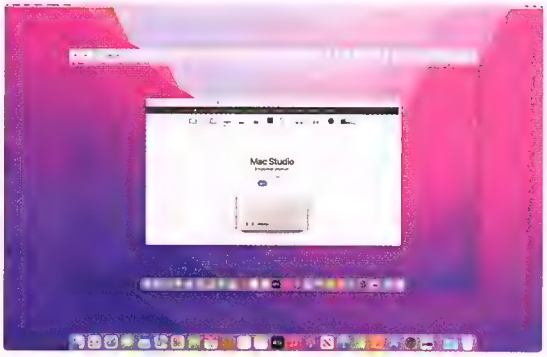
You might know that pressing command-up-3 will grab a screenshot of your entire Mac screen. But there are more options, and much more power baked into macOS that enable you to save what you want with minimal fuss.

For instance, you can draw a selection box on your screen, then move it around to the perfect position before firing the shutter. You can save a picture of a single app window, or even screenshot your Mac's Touch Bar.

There are tons of little-known options that bring a real dose of customisation to your screenshots. We've rounded up the best ones in this tutorial, complete with keyboard shortcuts that will help you get to work quickly and seamlessly.

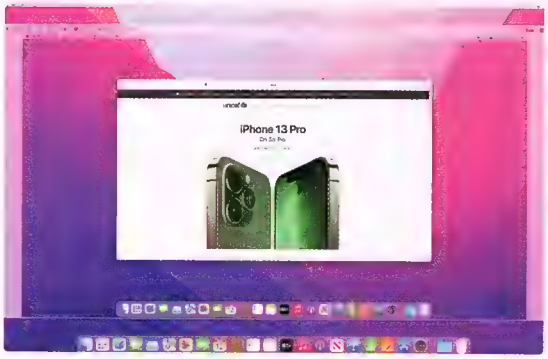
HOW TO TAKE SCREENSHOTS ON MAC

GENIUS TIP!
If you control-click the screenshot thumbnail when it appears, you get more options, such as opening it in Mail or showing it in Finder.



1 GET THE WHOLE SCREEN

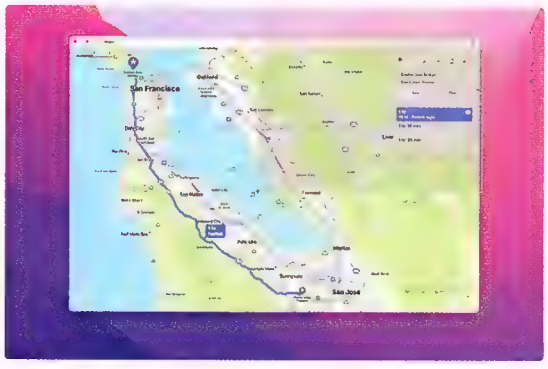
Press command-up-3 to capture your entire screen. Click the resulting thumbnail on your desktop to open an editing window, where you can tweak it in various ways, such as by adding a signature or cropping it.



2 SAVE TO CLIPBOARD

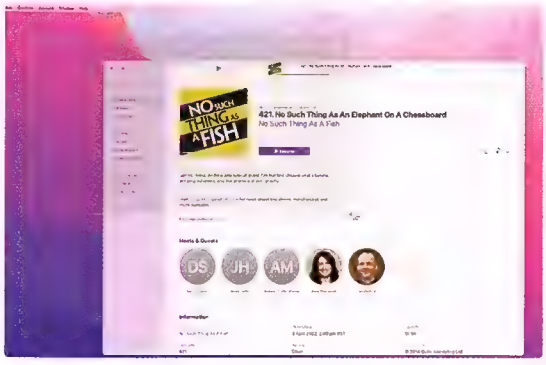
You can also save a screenshot to your clipboard instead of creating an image on your desktop with control-command-up-3 or control-command-up-4. You can then paste the capture into an image editor.

CONTINUED... TAKE SCREENSHOTS ON MAC



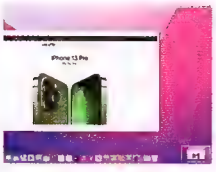
3 GRAB A SELECTION

Press command-up-4 to draw a box around an area. Release your mouse button and the area is saved as a screenshot. Before releasing, hold the Space bar to move the box, then release Space bar to set its new position.



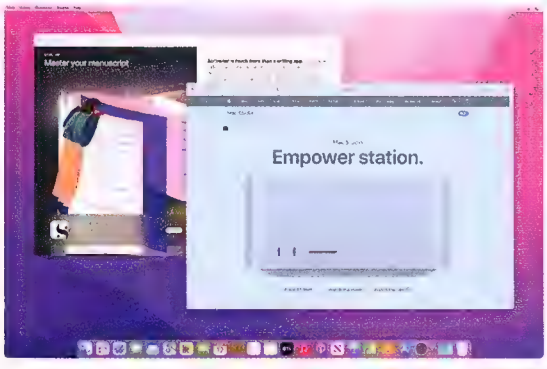
4 RESIZE THE SELECTION

You can resize this selection. Press command-up-4 then, before releasing your mouse button, hold up to scale the selection horizontally from one edge. Or hold option to expand it horizontally from the centre.



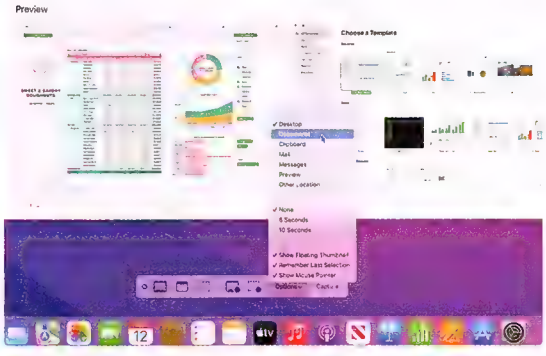
GENIUS TIP!

By default, macOS shows a temporary thumbnail preview of each screenshot on your desktop. You can disable this in the screenshot control panel.



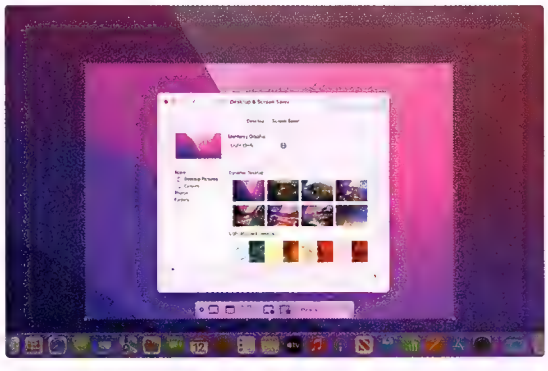
5 ONE APP WINDOW

Press command-up-4, then press the Space bar. When you hover over an app window, it will go blue – click to capture just that window. It'll save with the app's shadow by default; hold option before clicking to omit it.



6 CONTROL PANEL

Press command-up-5 to bring up the screenshot control panel. Click Options to tweak screenshot settings, such as where the image is saved, whether to use a timer, if the mouse pointer is included, and more.



7 RECORD A VIDEO

The control panel also lets you switch from capturing images to recording a video of your screen. As with images, you can capture the entire screen or just a section. Click the stop button in your menu bar to finish.

8 CHANGE THE FILE TYPE

You can use Terminal to change the default file format. Open Terminal and enter the following: defaults write com.apple.screencapture type -string "png". You can replace 'png' with bmp, gif, jpg, pdf, or tiff.

GENIUS TIP!

If your MacBook Pro has a Touch Bar, you can press command-up-6 to take a screenshot of just the Touch Bar and nothing else.

LINUX

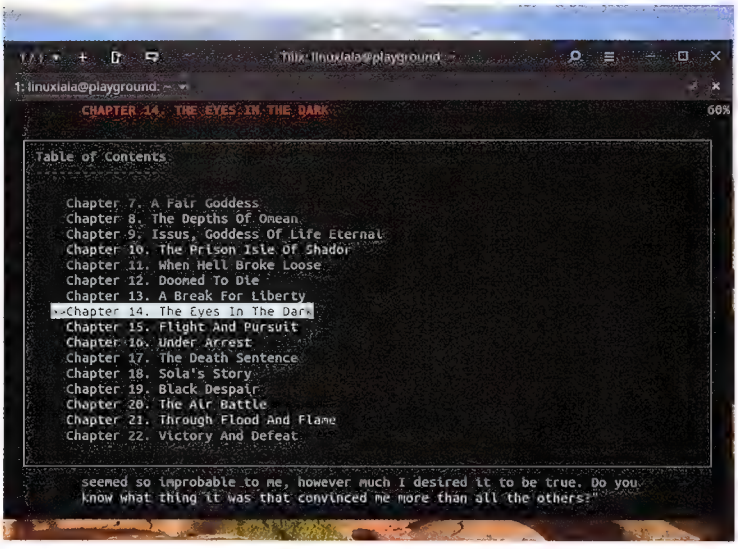
Bringing stories to the command line

Shashank Sharma knows that the Linux CLI, once seen as the domain of the uber geek, also serves as the pathway to the myriad worlds of stories.

A popular quote, often attributed to Albert Einstein, goes, "If you want your children to be intelligent, read them fairy tales. If you want them to be more intelligent, read them more fairy tales." Teddy Roosevelt was just as much a fan of reading, and is quoted to have said, "Now and then I am asked as to 'what books a statesman should read,' and my answer is, poetry and novels – including short stories under the head of novels." With many seminal works now available in the public domain, and ebooks being churned out with incredible frequency, for all this reading to be done, one needs the right tools for the job.

> "Unlike the parent project, Epy boasts several features such as bookmarks, external dictionary integration and URL support. "

In addition to Epy, which is an incredibly robust ebook reader that support a multitude of popular formats, we'll also discuss Ebook-convert, (see below) a nifty utility that can be used to convert ebook files from one format to another.


1: linuxlala@playground: ~
CHAPTER 14. THE EYES IN THE DARK
60%
Table of Contents
Chapter 7. A Fair Goddess
Chapter 8. The Depths Of Omean
Chapter 9. Issus, Goddess Of Life Eternal
Chapter 10. The Prison Isle Of Shador
Chapter 11. When Hell Broke Loose
Chapter 12. Doomed To Die
Chapter 13. A Break For Liberty
Chapter 14. The Eyes In The Dark
Chapter 15. Flight And Pursuit
Chapter 16. Under Arrest
Chapter 17. The Death Sentence
Chapter 18. Sola's Story
Chapter 19. Black Despair
Chapter 20. The Air Battle
Chapter 21. Through Flood And Flame
Chapter 22. Victory And Defeat
seemed so improbable to me, however much I desired it to be true. Do you
know what thing it was that convinced me more than all the others?"

The progress at the top-right of the screen is only visible if your terminal emulator window is wide enough. Press s to toggle it on or off.

Easy as pie

You might think that the choice of heading here has something clever to do with epy, but alas that isn't so. We settled on that heading because of the alliteration.

With the exception of Arch's AUR, you won't find Epy in the software repositories of most popular desktop distribution. But that's no cause for worry because the installation is fairly straightforward. If you already have pip package manager installed, you can install Epy with the **pip3 install epy-reader** command. Depending on your system configuration, you can either append **sudo** at the start of the command to install it for all users, or instead use the **pip3 install epy-reader --user** command to install the tool in the **~/.local/bin** directory.

Released under the GPLv3 license, Epy was forked by the author from his previous Epr utility, which itself was released under the MIT licence. Unlike the parent project, Epy boasts several features such as bookmarks, external dictionary integration and URL support.

QUICK TIP!

In addition to Project Gutenberg, there are other communities that provide access to public domain works. See Global Grey Books (**www.globalgreye books.com**) or Standard Ebooks (**https://standard ebooks.org**). If you're interested in scholarly or academic works, see HathiTrust (**www.hathi trust.org**), a not-for-profit collaborative efforts of various academic and research libraries.

CONVERTING EBOOKS

If you read ebooks on various devices such as tablets, desktop or Kindle, then it makes sense to retain ebooks in the format supported by all devices. While most desktop ebook readers support various popular ebook formats such as EPUB, MOBI and PDF, some devices such as Kindle are far more limited. It makes sense to have all your ebooks in the same file format so that they can easily be moved between devices per your convenience.

Thankfully, a nifty command-line utility does this trick. If you work with ebooks, you might already be familiar with Calibre, a popular graphical ebook manager. In addition to doubling as an ebook viewer, you can also use Calibre to download news and magazines from the web, share and backup your library, convert between ebook file formats, edit the metadata on your books and more.

You'll find Calibre in the software repositories of most popular desktop distributions. Once installed, you can use the included ebook-convert command-line utility to quickly convert files from one format to another.

To convert an EPUB file to MOBI format, run the **ebook-convert 2\ -\ gods-of-mars.mobi 2-Gods-of-Mars.epub** command.

Depending on the source ebook, you might wish to adjust the base font size, or move the table of contents (TOC) from the start of the file to the end. These adjustments and more can also be done with ebook-convert. Refer to the project's man page for more details.

If you already have ebooks at hand, you can start reading immediately by running the **epy /path/to/ebook.mobi** command. Apart from the mobi format, Epy also supports epub as well as azw and fb (fictionbook) formats.

When reading an ebook, you can access the table of contents (TOC) at any time by pressing t. The Epy project boasts of a number of keybindings, which you can access by pressing ?, but we'll list a few useful ones to help you get the most out of the reading experience:

Keybinding	Function
t	Open table of contents
c	Change colour
n	Go to next chapter
p	Go to previous chapter
d	Define word
b	Add a bookmark
B	List bookmarks
/	Regex search
M	View metadata information

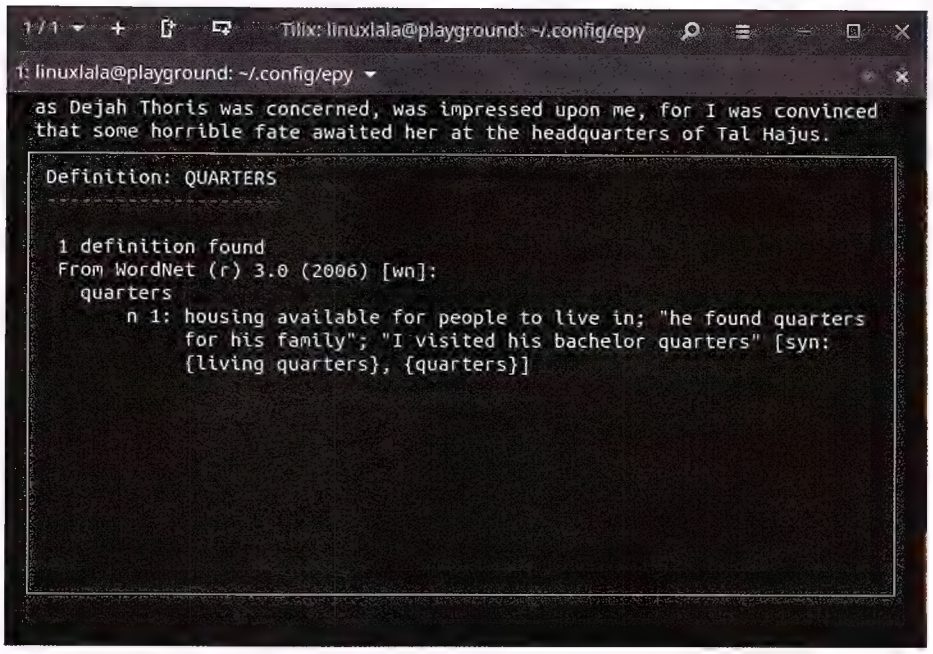
Start reading

The Epy tool remembers your reading history, so you don't have to specify the complete path to the ebook each time you launch Epy. Instead, you can run the **epy** command, and the project automatically opens the last ebook you were reading, at the location where you left off. Even better, when you specify the path to a book, Epy will open at the position where you left off. For instance, if you've just started chapter seven of book A, and then read three chapters of book B, when you open book A again, Epy will open it at chapter seven.

You can access your reading history by running the **epy -r** command:

```
1 17% 11:29PM Apr 01: Works of Edgar Rice Burroughs - Burroughs, Edgar Rice...
2 3% 10:15PM Apr 04: Thuvia, Maid of Mars - Edgar Rice Burroughs (/media/l...
3 20% 03:27PM Mar 27: The Gods of Mars - Edgar Rice Burroughs (/media/linux...
4 31% 05:57PM Apr 01: Swords of Mars - Edgar Rice Burroughs (/media/linuxla...
5 10% 03:27PM Apr 07: Llana of Gathol - Edgar Rice Burroughs (/media/linuxl...
6 35% 03:27PM Apr 07: A Princess of Mars - Edgar Rice Burroughs (/media/lin...
```

Each book in history is allotted a number. You can quickly open a book from the library using the assigned number with the **epy <num>** command. For instance, the command **epy 4** opens the *Swords of Mars* book from our reading library. The **epy -r** command also shows the progress as well as the date and time when the file was last accessed.


Tilix: linuxlala@playground: ~/.config/epy
1: linuxlala@playground: ~/.config/epy
as Dejah Thoris was concerned, was impressed upon me, for I was convinced that some horrible fate awaited her at the headquarters of Tal Hajus.
Definition: QUARTERS
1 definition found
From WordNet (r) 3.0 (2006) [wn]:
quarters
n 1: housing available for people to live in; "he found quarters for his family"; "I visited his bachelor quarters" [syn: {living quarters}, {quarters}]

Even if you make no changes, go through the ~/.config/epy/configuration.json file for an idea of the features on offer, such as text to speech and mouse support.

If you don't like the idea of repeatedly looking up the reading history to confirm the assigned number before opening a book, you can also use a match string to inform Epy of the book you wish to read with the **epy <string>** command opens the book that matches the specified search string. From our reading history, the command **epy princess** opens the first book in the series, while **epy swords** opens the eighth book in the classic pulp fantasy series.

Configuration

One of the greatest joys of reading is expanding one's vocabulary. But this only works if you can quickly look up the meaning of new words in a dictionary. Thankfully, Epy supports tools like Dict and Wkdict, which you'll find in the software repositories of most popular desktop distributions. Once installed, you can edit the **~/.config/epy/configuration.json** configuration file and make the necessary changes. Look for the **"DictionaryClient": "auto",** line and change **"auto"** to the name of the dictionary tool you installed. Because we installed Dict on our test machine, we changed the line to **"DictionaryClient": "dict",** .

When you now press d while reading a book, you'll be prompted to enter the word that you wish to look up in the dictionary.

You can also change the default keybindings by editing the **~/.config/configuration.json** file, which is also home to various other editable parameters. For instance, the Epy tool utilises an animation when scrolling pages in the book. If you find the feature distracting, open the configuration file in your favourite editor and change the **"PageScrollAnimation": true,** line to **" PageScrollAnimation": false, .** By default, the tool displays the reading progress at the top left corner, but this too can be turned off by changing the **"ShowProgressIndicator"** line in the config file.

In addition to the variety of ebook formats, Epy also supports working with URLs, so you can read books directly from Project Gutenberg without downloading them first. The command **epy https://gutenberg.org/files/1268/1268-h/1268-h.htm** enables you to read Jules Verne's *The Mysterious Island* without having to download an EPUB or MOBI format. Unfortunately, this feature only works for books that have been properly formatted in HTML, so you won't be able to indulge in fan fictions using Epy. ■

"One of the greatest joys of reading is expanding one's vocabulary. But this only works if you can quickly look up the meaning of new words in a dictionary."

RASPBERRY PI

Build a Python-based reaction game

Les Pounder goes back to the early days of the Raspberry Pi to look at a board that made a big difference to his career.

YOU'LL NEED THIS

Any Pi Raspberry Pi OS, Pibrella breadboard Button, Two M-to- M jumper wires, Code: **https://github.com/lesp/LXF-Pibrella/archive/refs/heads/main.zip**

Pibrella is an awesome little board. We first came across it in 2014 while delivering a training course and since then we've used it with hundreds of learners. This $25 board may be eight years old, but it's still a great way to get to grips with electronics on the Raspberry Pi. In this tutorial we'll learn a little about this board, and create a reaction game to prove who's the fastest of them all!

Because Pibrella was designed for the original 26-pin GPIO Raspberry Pi it has to connect to the first 26 GPIO pins of any Pi. The first 26 pins are from the micro SD card. With the Raspberry Pi powered off, connect Pibrella so that it fits directly on top of the Pi. No part of Pibrella should "stick out" from the footprint of the Pi. The included rubber foot will need to be positioned so that Pibrella doesn't touch the Raspberry Pi.

For the project you'll need to place a push button into a breadboard, then connect the legs of one side to Input A of the Pibrella. It doesn't matter which leg goes to which part of Input A, as long as you only use one side of legs from the button.

When done, connect your keyboard, mouse, HDMI, Ethernet and lastly power which goes directly to Pibrella via the micro USB. Once everything's connected, boot to the Raspberry Pi OS desktop.

From the desktop, open a terminal and run this command to install the Pibrella Python library.

```
$ curl -sS get.pimoroni.com/pibrella | bash
```

Answer the questions and perform a full install and after a few minutes we're ready to create our project. But first, let's get to know Pibrella and the Python library. Pibrella was initially designed to make interfacing with the GPIO as simple as possible. Pibrella became the go-to board for educators in the early days of the Pi.

> "This $25 board may be eight years old, but it's still a great way to get to grips with electronics on the Raspberry Pi."

On the left of Pibrella are four inputs (A to D), and to the right are four outputs (E to H). The outputs can drive 5V DC motors, but only in one direction – there's no "flip flop" H bridge to change the polarity of the outputs. At the bottom of Pibrella is a large red button, and above that are three LEDs (red, yellow and green) and a simple piezo buzzer.

Pibrella's Python library is simple. Using high-level (human readable) functions, Pibrella is easy to use. Let's work through a quick example. Open your favourite Python editor – we chose Thonny because it comes pre-installed on the Pi. Create a new file, and for the first two lines import the Pibrella library and the sleep function from Time.

```
import pibrella
from time import sleep
```

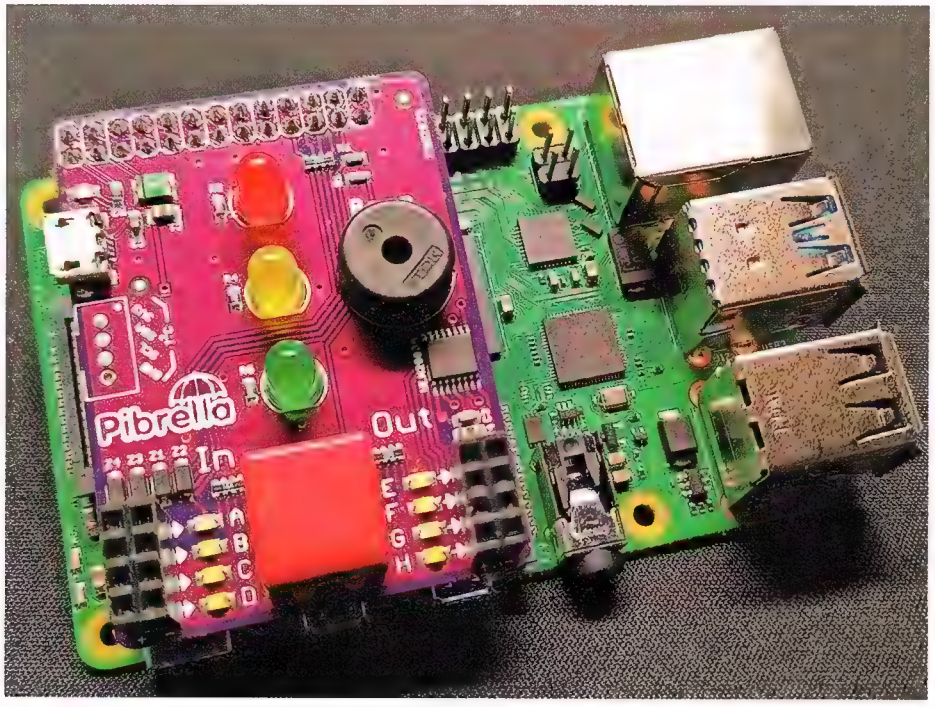
Now let's create a for loop that will iterate 10 times.

```
for i in range(10):
```

Inside the for loop we'll use a function to turn all of the Pibrella LEDs (red, yellow and green) on at one, then wait for half a second, before turning them off and waiting for another half second.

```
    pibrella.light.on()
    sleep(0.5)
    pibrella.light.off()
    sleep(0.5)
```

Save as pibrella-test.py and run the code. The LEDs will blink on and off. We can replace `pibrella.light.on()` with `pibrella.light.red.on()` to control just the red LED. Replacing red for yellow or green performs the same task for those LEDs. Armed with our new knowledge let's make a quick game.



Pibrella will work with newer models of Pi. Just remember to place it on the first 26 pins of the GPIO.

Writing the project code

Create a new file and import three libraries. Pibrella and sleep, just like we did before, but we also import random that we shall use to generate a random number.

```
from time import sleep
import pibrella
import random
```

Create a variable, time, which will store a randomly chosen

number between 5 and 10. This will make our reaction game a little more challenging because we don't know when the LED will light up.

```
time = random.uniform(5,10)
```

Using the randomly generated number we tell the code to sleep (pause) and then turn on the green LED, our trigger for the reaction game.

```
sleep(time)
pibrella.light.green.on()
```

Next, create a while True loop to continually run the code within.

```
while True:
```

Now we read the two buttons for player one and two, then store the values in variables p1 and p2. Player one is connected to Input A, and player two is using Pibrella's button. For both buttons we use the loop to continually read the state of the inputs. By default they will read "0" but when pressed they will read "1", as described by the following:

```
p1 = pibrella.input.a.read()
p2 = pibrella.button.read()
```

We next use a conditional test that uses two if conditions to check the value stored in the variables p1 and p2. If p1 (player one) variable is storing "1" then we know that they pressed the button first. If that is the case we'll blink the yellow LED using Pibrella's blink function. We set the duration on and off to be 0.5 seconds. Then the code will pause for five seconds before we break out of the main loop.

```
if p1 == 1:
pibrella.light.yellow.blink(0.5,0.5)
sleep(5)
break
```

The same test is performed for player two, but this time the red LED will blink.

```
if p2 == 1:
pibrella.light.red.blink(0.5,0.5)
sleep(5)
break
```

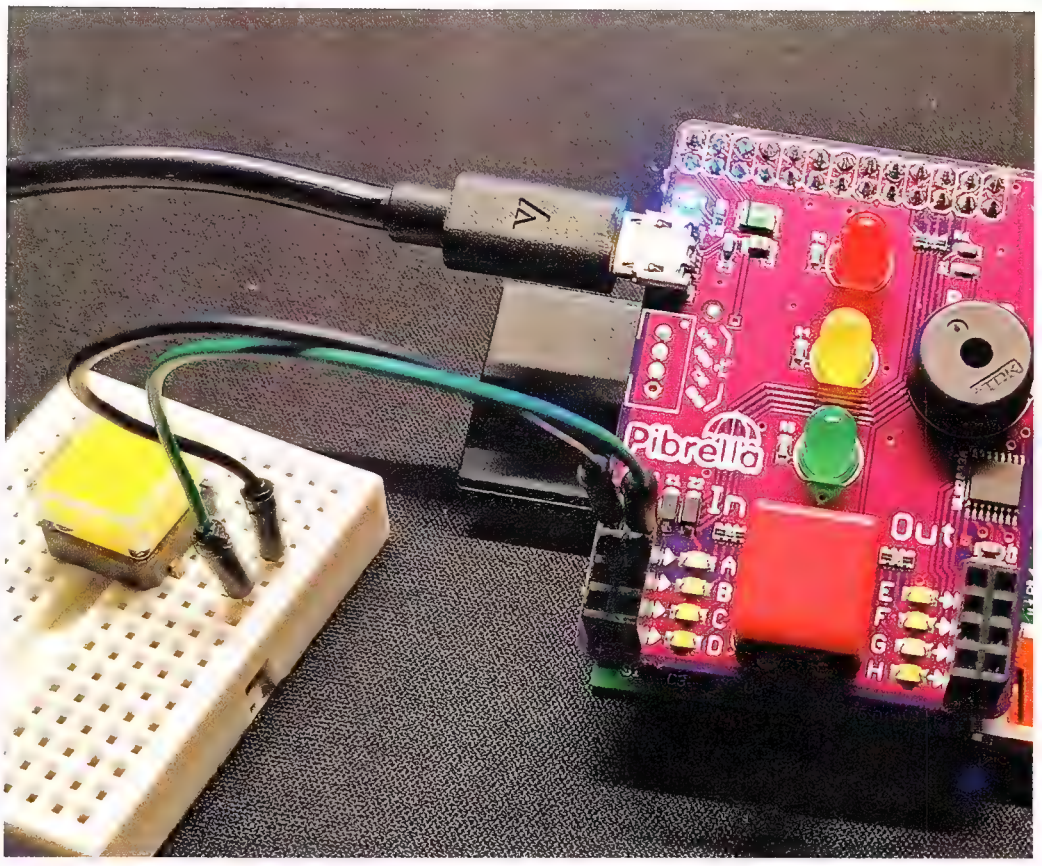
Pibrella's buzzer can produce simple sounds at varying frequencies. It won't produce high-quality music, but with a little practice you can get a tune out of it. Luckily for us the Pibrella Python library has two tunes – success and fail – that we can drop into our game. Now out of the while True loop, we're going to play a "success" tone to signal game over.

```
pibrella.buzzer.success()
```

To finish, we tell the code to pause for two seconds before turning all the LEDs off, which will signify that the game has ended.

```
sleep(2)
pibrella.lights.off()
```

Save the code as reaction.py and then run the game. After a random amount of time, the green LED will turn on and then it's "fastest finger first" to press your button and win the game! ■



Pibrella makes electronics simple. We can even use it with ScratchGPIO to make electronics projects in a block-based coding environment.

GENIUS TIP!

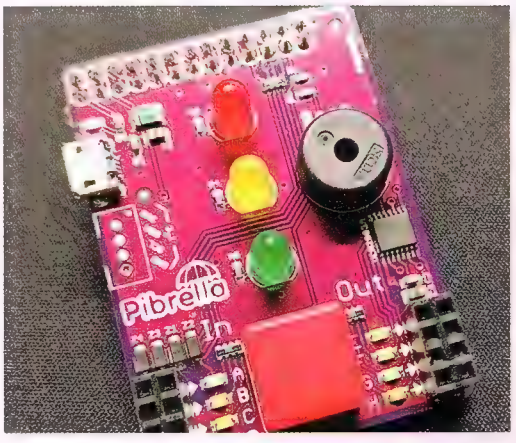
Powering Pibrella should always be via the onboard micro USB port. This provides power to the Pi and Pibrella, while also providing a small amount of protection when using high- current draw components such as motors.

HATS, INSIDE AND OUT

Pibrella is from a time before the Raspberry Pi GPIO was expanded to 40 pins, and a time when boards had a specification to follow. The HAT (Hardware Attached on Top) standard was introduced with the Raspberry Pi B+ and as well as extra pins it brought a form factor standard which is still in use to this day.

HATs must be 65mm wide, 56.5mm length and provide 8mm of clearance from the Raspberry Pi. The corner radius should be 3mm and at each corner there should be an M2.5 screw hole for compatible standoffs. There should also be cut-outs for the official Raspberry Pi camera (CSI) and display (DSI) ribbon cables to pass through under the HAT. An example of this is the Sense HAT, which has a cut-out for the camera.

To be officially called a HAT there needs to be a valid ID EEPROM at pins 27 and 28. This EEPROM identifies the board to the Raspberry Pi and tells the Pi how to set up the GPIO and other devices. Boards that follow the mechanical requirements of the HAT standard are not really HATs, but many are still called a HAT and the term has become part of the general language used by the community.



Four input, four outputs, some LEDs, a big red button and a rather annoying buzzer. A good deal for $25 some might say!

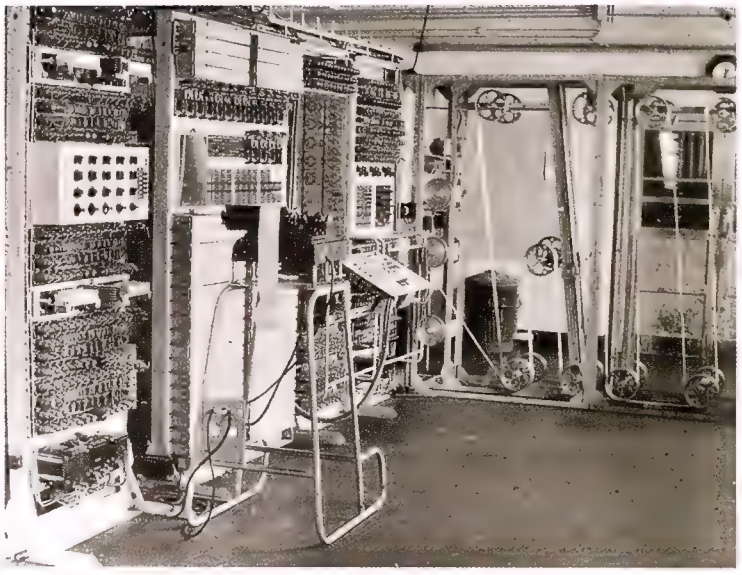
ELECTRONICS

Tech that changed Australia (and the world) – Part 3

As World War II reaches Australian shores, secret radar research here is matched by the ultra-secret British development of the world's first electronic computer. Darren Yates explains.

The creation of the cavity magnetron in February 1940 couldn't prevent the fall of France in June and Australian scientist Mark Oliphant, leading the team in England developing the magnetron, sent his family home to Australia. Yet throughout 1941, Japan and the U.S. remained at loggerheads over oil and the Japanese invasion of China. On December 7, Japanese forces attacked the U.S. naval base at Pearl Harbour and the following day, Australia joined a coalition of nations, including the U.S. and U.K., in declaring war on Japan. War was set to transform Australian science and technology.

"Australia was not only a recognised leader in valve technology, we were also pioneering new research in radio-direction and ranging or 'radar.'"



A Colossus computer during late-1944/early-1945.

More made in Australia

Fears that Australia could be cut off from England in the event of a Pacific war looked like becoming reality in early-1942, with the fall of Singapore on February 15 and the first bombing of Darwin four days later. The original 1,400-sq-metre factory built by Amalgamated Wireless Valve (AWV) in Sydney's inner-west just nine years earlier could no longer meet the demand for radio valves and by March 1942, a huge new 5,600-sq-metre multi-level factory had been constructed on the Ashfield site. Many of the radio valves now made here included Australian-designed power-efficient valves that would soon drive new military communications equipment.

The 'Shore Defense' radar at Dover Heights, looking towards North Head in 1943 (Image credit: CSIRO Radio Astronomy Image Archive).

Secret research centre

By this time, Australia was not only a recognised leader in valve technology, we were also pioneering new research in radio-direction and ranging or 'radar'. Australia's reliance on radio communications meant Australian scientists, such as physicists David Martyn and Jack Piddington, were world-renowned in understanding radio-wave travel or 'propagation' and the outbreak of war in Europe saw Australia become a secret centre for radar research. The Council of Scientific and Industrial Research – the forerunner to today's CSIRO – even named the 'Radiophysics Laboratory' as a cover to hide its real purpose of radar research. One of its earliest contributions, later adopted in England, was to combine the previously separate transmitter and receiver masts into a single unit, reducing size and cost. The Shore Defence radar system keeping watch at Dover Heights in Sydney's east in 1940 was the first in the Commonwealth to use this system. Even in its first trials in May 1940, the Dover Heights radar identified a ship off Port Stephens, 150km to the north.

At that time, attacks by ship were thought the danger. However, the Japanese attack on Pearl Harbour in December 1941 quickly shifted attention to aircraft detection and despite a lack of suitable valves, some

local ingenuity (including by AWV engineers) had a modified Shore Defence radar set soon detecting aircraft 100kms off the coast of Dover Heights.

But this is only half the story. The fall of Singapore motivated Oliphant to return to Australia, not arriving until May. However, his arrival coincided with the major sea-and-air battles of the Coral Sea in May, and Midway in June. The sinking of four Japanese aircraft carriers at Midway eased fears of imminent invasion and within months, Oliphant was on his way back to Britain. Yet during his short stay, he was persuasive in pushing radar development for the island-hopping Pacific offensive to come. Allied forces needed an air-warning radar that was light-weight, easily carried anywhere, quickly pieced together and made operational, but would also survive the climate of jungle warfare.

It was no mean feat that by September 1942, engineers of the Radiophysics Laboratory and the RAAF completed the prototype of a design that would prove invaluable in the battles ahead.

Colossus, the forgotten computer

Meanwhile, British codebreakers at Bletchley Park had, by this time, cracked the Enigma cipher machine and were dealing with 'son of Enigma', the Lorenz SZ40. While Enigma encrypted routine messages (read daily by Alan Turing's 'Bombe' machines), the SZ40 sent critical messages to German field commanders – to read these messages would be to read the German war machine like a TV program guide. Yet the SZ40 was so complex, it made Enigma look like a toy. What's more, the codebreakers had never seen one.

Nevertheless, in 1942, a young mathematician, Bill Tutte, performed one of the great feats of mathematical deduction, hacking the SZ40 using only intercepted cipher messages. His work led to the rout of German forces at the battle of Kursk in Russia in July 1943. The problem was hacking the messages by-hand took ages, potentially reducing the value of the information within.

A machine dubbed 'Heath Robinson' for its complex DIY appearance aimed to accelerate the decrypt process, but was apparently as unreliable as it looked. Tommy Flowers, an electrical engineer seconded to Bletchley Park at the time, saw the machine and had an idea for a solution using valves – lots of valves – but his superiors dismissed it as a waste of valuable components.

Flowers listened politely, then headed back to the Post Office Research Station in London's Dollis Hill and started building his idea anyway. It took much of 1943, but by December, the 1,600-valve behemoth dubbed 'Colossus' came to life. The world's first electronic computer not only impressed the 'top brass' on its arrival at Bletchley Park in January 1944, they immediately ordered ten more. The first of these, a five-times-faster, more powerful 2,400-valve 'Mark II' (the original 'PC upgrade'), was ready just before the D-Day invasion in June.

By war's end in 1945, a dozen Colossus computers were in action, but in a decision that irrevocably altered the course of computing history, Prime Minister Winston Churchill ordered all but two of the computers – and all design plans – destroyed. Moreover, the men and women of Bletchley were silenced by the Official Secrets Act from ever talking about their war-time exploits.

The radar antenna and block house at Dover Heights, 1943 (Image credit: CSIRO Radio Astronomy Image Archive).

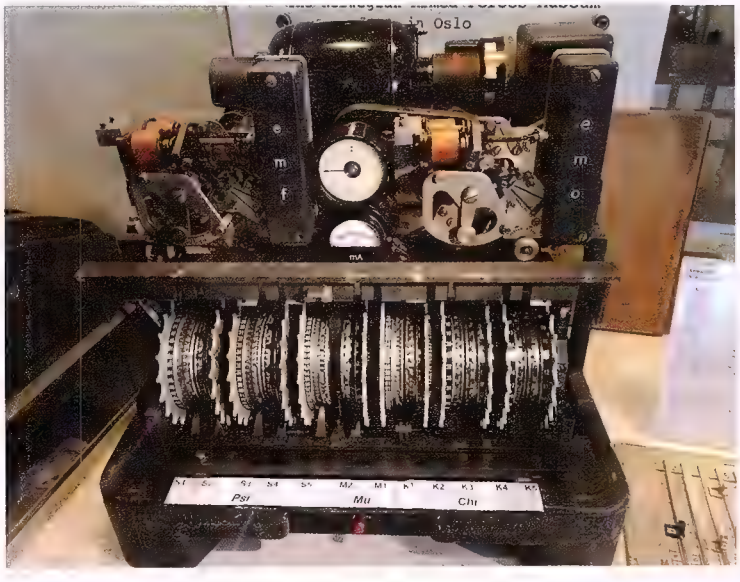
Many, sadly, took their secrets to the grave and it wasn't until the 1974 book 'The Ultra Secret' by F.W. Winterbotham that the world first glimpsed the codebreakers' war. In 1977, Tommy Flowers appeared in the BBC series 'The Secret War', telling his story for the first time.

It's generally recognised that without Colossus, the war could have lasted two more years, costing millions more lives. Yet so secretive was its war-time work, Britain's Government Communications Headquarters (GCHQ) only released its report detailing the SZ40 hacking in October 2000.

The irony is, despite the destroy-all-plans order, a fully-working Colossus Mark II computer was reconstructed in 2008 and now stands at the National Museum of Computing at Bletchley Park.

It's anyone's guess how the history of computing may have been rewritten had Britain the freedom to pursue its war-time invention. ENIAC put the U.S. on the computing map in 1946 and, as we'll soon discover, Australia wasn't far behind.

However, next time, we celebrate a special anniversary and relive the story of Australia's first female electrical engineer and her legacy that lives on today in the pages of *APC*. ■



Above: Tommy Flowers, inventor of the Colossus computer.
Left: The upgraded Lorenz SZ42 teleprinter (Source: TedColes, CC-BY-SA 4.0).

BENCHMARKING 101

Quantitatively measure your PC performance

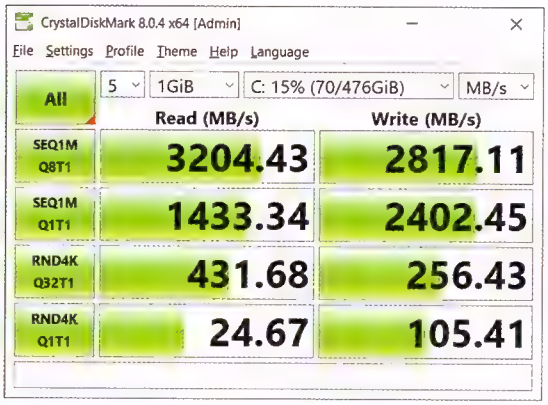
At APC, we're always about squeezing more speed from your PC. But how do you know for sure which methods get you the most gains? Darren Yates explains the ins and outs of PC benchmarking.

Understanding PC performance can seem a bit like peering into a black box – you've got a gut feel for your PC's speed, but you can't quite see what's really going on. That's where the science of benchmarking comes in – it allows you to measure in a repeatable way where your device performance is up to. Benchmarks aren't perfect, but having designed and used them in 20 years of lab work, I'm looking this month at how benchmarks work and how to get the most out of them.

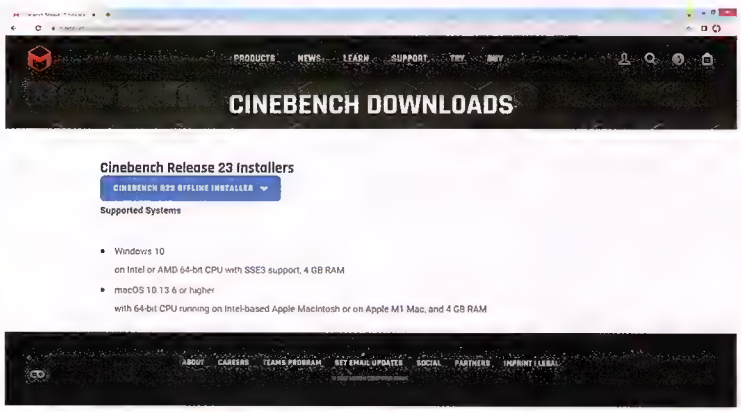
"No matter which benchmarks you use, the first step to improving your PC's performance is always to know what it's doing right now, what you call your 'ground truth' or 'baseline' performance."

How do benchmarks work?

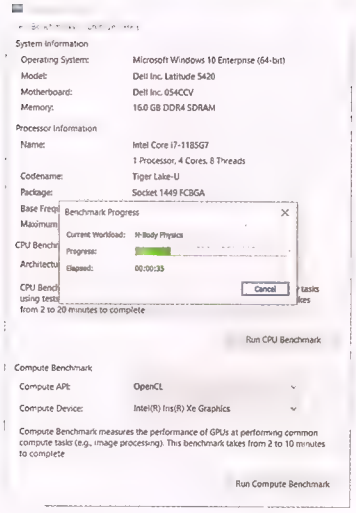
Essentially, a benchmark measures the performance of your PC (or component) by executing a fixed set of repeatable tasks against the clock, whether its data transfer, video encoding, whatever. It first notes the current system clock time, runs through the tasks, records the current time again, then calculates the difference and determines a speed rating. But to make sense of these scores, it may also feature one or more overall comparison scores. For example, the popular GeekBench 5 returns two scores – one for single-core tests, another for 'multi-core'. The key with these scores is they are referenced or re-scaled against an Intel Core i3-8100 PC.



CrystalDiskMark is ideal for testing data throughput rates for your HDDs and SSDs.



Above: CineBench uses Maxon's Cinema 4D ray-tracing engine to test your PC hardware. **Right:** GeekBench 5 requires internet access for free use, but is cross-platform.


System Information
Operating System: Microsoft Windows 10 Enterprise (64-bit)
Model: Dell Inc. Latitude 5420
Motherboard: Dell Inc. 054CCV
Memory: 16.0 GB DDR4 SDRAM
Processor Information
Name: Intel Core i7-1185G7
1 Processor, 4 Cores, 8 Threads
Codename: Tiger Lake-U
Package: Socket 1449 FCBGA
Benchmark Progress
Current Workload: N-Body Physics
Progress:
Elapsed: 00:00:35
Cancel
from 2 to 20 minutes to complete
Run CPU Benchmark
Compute Benchmark
Compute API: OpenCL
Compute Device: Intel(R) Iris(R) Xe Graphics
Compute Benchmark measures the performance of GPUs at performing common compute tasks (e.g., image processing). This benchmark takes from 2 to 10 minutes to complete
Run Compute Benchmark

Scale-what?

Scaling is just a simple mathematical method for simplifying performance comparisons and allows you to quickly compare your result against other systems without having to think too much about it. Again, using our GeekBench 5 example, let's say the developers run the raw benchmark tests on their Core i3-8100 reference PC and it takes 45 seconds to run the 'integer' test set. This score is re-scaled to 1000.0 as a baseline result. Now you come along with your AMD Ryzen box, run the same test and a run time of 22.5 seconds is recorded. But instead of time scores, GeekBench 5 returns a 'scaled' score we believe is calculated like this:

score = (ref_time/test_time) x 1000

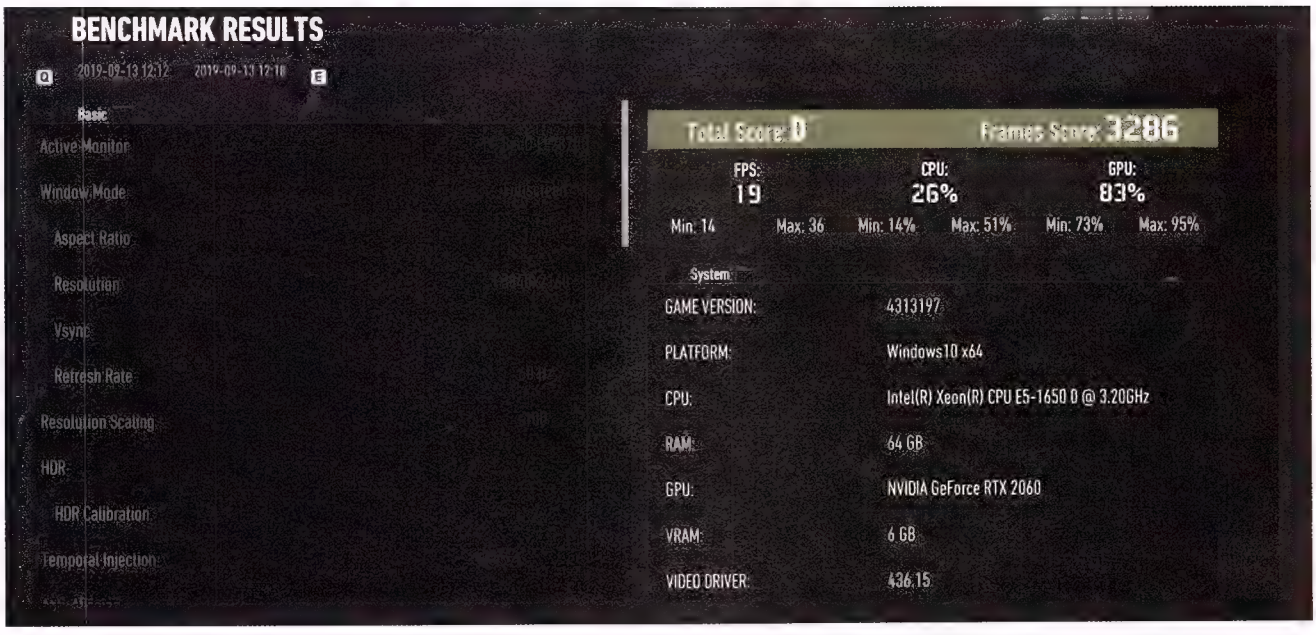
where 'ref_time' is the run time for the Core i3-8100 reference PC, and 'test_time' is the run time of your test system. In our example, the score would be (45/22.5) x 1,000 = 2,000 – this tells you that your Ryzen PC is exactly twice as fast as their Core i3 reference or baseline. Conversely, a number less than 1,000 here would indicate your system is slower than the baseline reference.

Baseline performance

No matter which benchmarks you use, the first step to improving your PC's performance is always to know what it's doing right now, what you call your 'ground truth' or 'baseline' performance. There are two ways to do this – you can run broad-function system-wide benchmark tests that look at your device as a whole, or drill down to component level and use component-specific benchmarks. We'll cover benchmark apps in a sec, but for now, understand that you need to know your baseline performance level to know whether any future change is moving you forward or holding you back.

Which benchmarks?

Given you're reading APC, it makes sense in most cases to use the same benchmarks we do for two very good reasons. First, we use the latest high-performance benchmarks that allow you to get a good handle on how your system



fares right now. But second, you can also compare your results with those we publish from new systems and components we review. Armed with this knowledge, you can make informed decisions on whether a new CPU, laptop or component is right for you.

So, here's a short recommended benchmark list for modern systems:

System-wide tests GeekBench 5, CineBench R23

Gaming (video card) tests Many games have in-game benchmarks, we use Far Cry 6, Metro: Exodus and Ghost Recon: Breakpoint.

Disk (HDD/SSD) speed tests CrystalDiskMark

GeekBench 5 is also cross-platform, so it'll work on not just your PC, but also your phone and tablet.

Setting up for a benchmark run

Benchmark results are influenced by when and how you run the tests. For example, if you're in the middle of an 8K video re-encode, don't decide to run a benchmark test. It's a safe bet the result will be lower than if you ran it just after a reboot – that's because the benchmark test doesn't have the PC's undivided attention. You must shut down all other apps and games before commencing a benchmark test. This isn't about artificially boosting or faking scores – it's about setting a consistent, rock-solid repeatable platform and you can't do that if you've got 50 other things going on at the same time. What's more, if you do reboot, wait five minutes or so, just to give your OS time to get its background tasks sorted before starting a run.

Change one thing at a time

Not all upgrades involve spending money – now that you've got your benchmarks, you can use them to tweak different in-app, in-game or in-system settings and see what effect they have on the performance by comparing simple 'before' and 'after' results. You run the test before you make a change to set your baseline, then make your change, run the test again and get your 'after' result.

Here's an important tip – only make one change at a time between benchmark runs. To understand where your system performance is going up and down, you must only make one change at a time, otherwise you won't know which change is making the greater contribution to performance levels. And don't forget to tabulate your results (you can thank me later).

Traps for new players

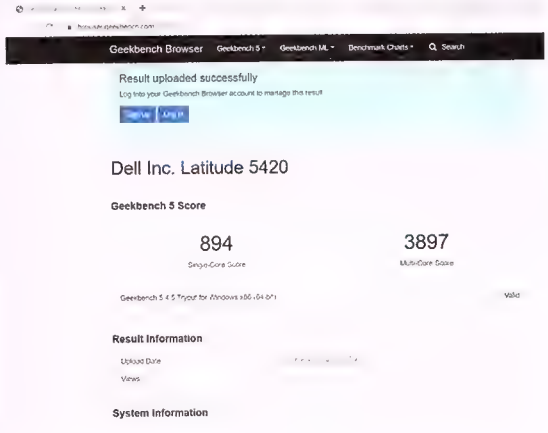
Still, with all that said, benchmarks are an important quantitative tool, but they don't always tell the full story. For example, you replace your hard drive with an SSD and your favourite benchmark says data transfer performance has improved three-fold. This doesn't mean your PC's overall performance will suddenly jump by the same amount. Remember that computing devices are an interlinked chain of multiple components and a big boost in one component won't necessarily translate into the same boost everywhere else.

Perform multiple runs

Another thing is to understand the caching effect – the first time you run a benchmark, your computing device has to search for files, load them up and execute tests on them. However, if you run the benchmark again, those files or at least their locations are now cached and this can speed up the result. This tends to happen with benchmarks that perform a single run only. Running benchmarks multiple times and averaging the results will give you a more uniform return. But again, it depends on what you want to test. That's why it pays to understand how a benchmark works.

Benchmarking is a great way to learn where and how device performance is affected by both hardware and software changes – and with many benchmark apps now free to download, the only real cost is the time you put in. ■

Ubisoft games like *Far Cry 6* and *Ghost Recon: Breakpoint* include an in-game benchmark.



GeekBench 5 tests single and multi-core processing using multiple tests.

DOWNTIME

LEARNING ABOUT OLD MACHINES AND BRINGING THEM BACK TO LIFE VIRTUALLY

MACHINE OF THE MONTH

Apple Macintosh II

John Knight waybacks to the Mac that made computers beautiful as well as practical.

■ **CPU:** Motorola 68020 @ 16Mhz **RAM:** 1–8MB, 128MB **Graphics:** 640x480 maximum resolution, maximum 16.7 million colours **Storage:** 3.5-inch floppy, 800 KB–1.4 MB, plus 40MB and 80MB hard disk upgrades **OS:** System 4.1–System 7.5.5 **Released:** March 1987 **Production:** 1987–1993.

Although the Macintosh II is rarely mentioned in retro computing circles, it introduced monumental changes, bringing colour graphics, a shift towards a 32-bit architecture, and multi-monitor support. For the retro enthusiast, the Macintosh II line has a sizeable library of excellent applications and multimedia, industry-leading desktop publishing software, as well as cult favourites in gaming and "edutainment".

Development

When the original Macintosh launched in 1984, despite its elegant styling and interface, the computing world was disappointed to find few opportunities for hardware expansion, and graphics only in black and white.

In 1985, engineers Michael Dhuey and Brian Berkeley began work on a sequel, without the permission or knowledge of Steve Jobs, who led the Macintosh division at the time. Against Jobs' wishes, this new machine would feature colour graphics, and in a move back towards the openness of the Apple II, easily accessible expansion slots, using MIT's NuBus system.

After Jobs was fired in September 1985, the Macintosh II enjoyed open and official development under the new project head, Jean-Louis Gassée. On the 2nd March 1987, the Macintosh II had its debut appearance at the AppleWorld Conference, before shipping to the public in April.

The Macintosh II ditched the small all-in-one design in favour of a PC-like desktop case with separate components. This was also the beginning of Apple's expensive era, where Macintosh computers were marketed as premium products, aimed at elite users and desktop publishing professionals. The base model only came with an 800KB floppy drive, but a 40MB hard drive model was also available.

Inside, the Mac II sported a 32-bit Motorola 68020 CPU running at 16 MHz, combined with a 68881 FPU. RAM was 1MB as standard, expandable up to 8MB. Graphically, it was capable of 16.7 million colours and a maximum resolution of 640x480 (at 256 colours). Customers could choose between a cheaper 12-inch black and white screen, or a highly-praised 13-inch monitor based on Sony Trinitron technology. Multiple monitors could be attached and windows could be dragged between screens.

For an operating system, the Mac II was initially lumbered with System 4.1 – a single-tasking relic from the 16-bit era used by other Macintosh models that relied on external software workarounds for multi-tasking.

Software

Desktop publishing is the Mac II's strongest point. Having a 16.7 million colour palette back then was a revelation for photo editing, where users could finally enjoy true colour rendering. Adobe Photoshop (1990) got its start on the Mac II and shared the platform with desktop publishing stalwart QuarkXpress (1987), plus a version of Microsoft Word 5.0 (1991).

Gaming-wise, the Motorola CPU had a weak point with 3D games, though more powerful models did receive an enhanced port of Wolfenstein 3D (1994), and there was the system's all-time classic first-person shooter, *Marathon* (1994).

However, the Macintosh II had many classic 2D games, from *Civilization* (1992) and *Where in Time is Carmen Sandiego?* (1990) to fantasy RPG *Realmz* (1994), Japanese sci-fi platformer *Thexder* (1990), and the graphically sharpest version of *Flashback* (1992) on any system. There is of course the obligatory port of *Prince of Persia* (1992), which is a particularly sleek version.

Above: This model threw away the cutesy (but limited) design of the original in favour of something closer to an IBM PC.

YOU'LL NEED THIS

A copy of Mini vMac Plus working system ROM and OS image. **https://www.gryphel.com/c/minivmac/download.html**

Legacy

Initially, things went well. Between the Macintosh II and Macintosh SE, Apple finally sold a million Macs in 1988. The easy access to the machine's internals opened up a new market for third-party components, and the upgrades kept coming with a bewildering number of model lines.

In September 1988, the Macintosh IIx arrived, with a faster 68030 CPU. A hard drive and the new 1.4 MB "SuperDrive" floppy were now standard. These machines were becoming seriously expensive, and this would soon backfire. Commodore and Atari sold computers with the same CPUs for dramatically cheaper prices, but Apple wanted to be seen as superior and more sophisticated.

PIC: © Wikipedia

In April 1990, Apple released the top-of-the-line Macintosh IIfx. This "wicked fast" powerhouse not only had a ridiculous 40MHz clock speed but had more efficiency per clock cycle and exotic hardware to push the Motorola CPU to its limits.

Expense aside, Apple's "32-bit" label was causing serious problems with its customers. Despite having a 32-bit CPU, earlier models were stuck in an awkward "24-bit" space, due to legacy components and software. This prevented the line from using the full 32-bit capabilities of its CPU, kept the RAM limit stuck at 8MB instead of 128MB, and caused software crashes and incompatibilities with 16-bit software in 32-bit environments.

In 1989, the Macintosh IIci was the first to introduce a proper 32-bit system, capable of addressing 128 MB of RAM. Hardware upgrades were released to make older machines truly 32-bit, but software workarounds such as Mode32 (1991) by Connectix eventually allowed 32-bit operation and full RAM access, before Apple included their own software 32-bit enabler in System 7.1.

The last Macintosh to wear the "II" nameplate was the Macintosh IIvx in 1992, before the line was discontinued in October 1993. Ultimately, the Macintosh II line was too expensive to sell in large numbers. Microsoft's bundling of Windows 3.x with computers ensured that the lower end of the market stuck with PCs, which might explain why we can't find sales numbers.

Above left: *Marathon* (1994) provided a Macintosh-exclusive alternative to *Doom* and established developer Bungie. **Left:** The Macintosh II's advanced colour graphics paved the way for the very first version of Adobe Photoshop.

Emulation

Macintosh emulation can be difficult, but we've streamlined the process as best we can. The two main emulators are Mini vMac and Basilisk II. Advanced users should try Basilisk II, but Mini vMac is easier to get started and more stable, so we'll use that.

Before emulating the Macintosh II you need a system ROM, an image of Macintosh OS, and a copy of StuffIt Expander (everything in Mac world uses StuffIt). Legally, we can't recommend system ROMs or OS images unless you own the original products. But if you are in the clear, archive.org has a collection of Macintosh system ROMs. 'Mac II FDHD & IIx & IIcx' ROM works best.

As for the OS, for compatibility's sake, we would recommend grabbing both System 6 and 7. Visit macintoshgarden.org and there are software entries entitled "Mac System 6 Collection" (tweaked specifically for Mini vMac), and "Mac OS 7.5.3 (for emulators)".

Getting Started

Once you have all the prerequisites, head to the Mini vMac website and open the Download page. Click the link 'Download Macintosh II Variations'.

The Windows ZIP file contains a single executable file called Mini vMac.exe. The Linux package contains a single executable that you may be able to run just by clicking on it. Otherwise, open a terminal and enter:

```
$ ./Mini\ vMac
```

Once started, Mini vMac will display an error about not finding a ROM image. Drag your chosen system ROM onto the Mini vMac window, and if your ROM is recognized there will be a loud beep and a floppy disk icon. This is a normal Macintosh screen – it wants a system boot disk. Click and drag your OS image onto the window and, all going well, your OS should boot.

Once your OS has loaded, you can explore disk images by dragging them onto the emulator window. If the image mounts successfully, a disk icon will appear on the desktop. If Mac OS says the disk image isn't readable, click Eject. Do not click Initialise – you may wipe out the image file.

Firstly, Mini vMac runs at 8x speed by default. To change the speed, press Ctrl-S, then while keeping Ctrl held down, press Z. To make the window fullscreen, press Ctrl-F. ■

FINDING SOFTWARE

For a huge archive of abandonware software, check out macintoshgarden.org, which often provides handy .DSK and .IMG formats. There is a great collection of software archive links at vintagemacmuseum.com, but you will quickly run into a problem: most Mac software comes in .HQX format, which doesn't work with Mini vMac. You can either try the more advanced (and less stable) Basilisk II emulator or, alternatively, you can visit: **www.macintoshrepository.org**, where you will find instructions for how to convert these files under a page called 'How to wrap loose old Mac files into a disk image'.

PIC: Bungie, Adobe Photoshop

GAMES

Hardspace: Shipbreaker

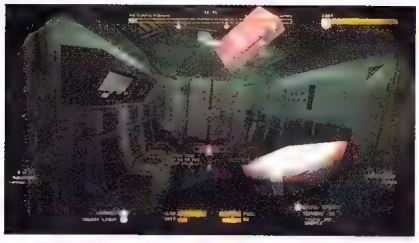
Work off your debt one salvage job at a time.

■ $47.95 | PC | focus-entmt.com

apc EDITOR'S CHOICE

Hardspace: Shipbreaker has come a long way since entering Early Access, but the core shipbreaking has been consistently satisfying since day one. Here's the deal: every morning you begin a shift, picking a new ship to crack or continuing one from the day prior. Each ship is built like, well, a ship – airlocks, engines, reactors, and crew compartments layered inside a structural frame and layers of hull panelling to protect them from the elements.

Your first ships are simple enough. Everything can be sorted into three piles – the processor for stuff your employer Lynx wants recycled (usually hull panels), a barge for stuff it wants reused (computers, engines, furniture), and a furnace for scraps it wants rid of. Each piece properly scrapped adds progress towards your work orders, with higher rewards the more efficiently you dispose of a ship. Destroying or misallocating too much salvage will incur penalties and negligence can even lock you out of the more lucrative rewards.



As you mop up these stripped-out shuttles, you'll earn commendations with the company, and with them access to bigger, more complex ships to scrap. Very quickly you're forced to deal with pressurised compartments which will explosively, err, 'decompress' if not vented properly, fuel lines that will start fires if accidentally ruptured, and power boxes that, if mishandled, will set electricity coursing across the ship.

Fortunately, earning promotions also gives you more tools to break ships with. Improved grapples and cutters, scanners to check the pressurisation levels before playing with lasers, remote detonators to sever an entire ship's cut-points at once, and tethers that let you pull at objects too heavy for your grapple.

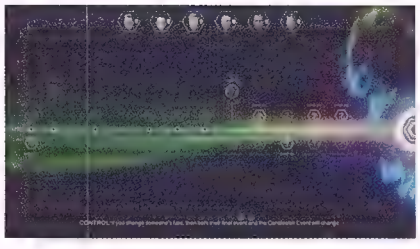
Shipbreaking is a trade, and as you learn the intricacies of each ship class, you start to build little efficiencies and shortcuts. How to place your cutter just right to hit multiple cut points at once, how to use atmospheric decompression to your advantage, the best ways to drag those heavy Atlas engine plates into the processor, and the trick to cutting the floor out of a Mackerel and yoinking the reactor straight into the barge. It feels like work, sure, but in the most satisfying way possible. *Shipbreaker*'s derelicts are simply a delight to break apart, and there's a real joy to peeling apart what looks at first glance to be a single, solid object until there's nothing left but dust and loose trash.

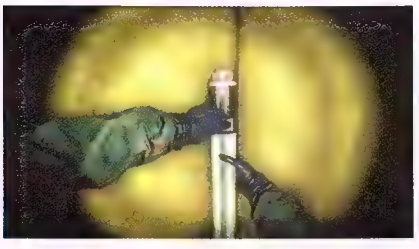
It's a game about being proud of a job well done, and fighting to make your workplace one you can be proud of. It's a deliberately repetitive thing, which might be tedious if you can't find enjoyment out of methodically cutting apart ships across two, three, even four continuous shifts.

A satisfying disassembly sim wrapped in cutting workplace commentary, *Shipbreaker* is a gig worth taking up.

Nat Clayton

★★★★½





ETERNAL THREADS

Sends you back in time to fix some broken hearts.

■ $44.95 | PC, PS4, XB1, Switch | eternalthreadsgame.com

Time travellers should be able to stop a house fire with ease. All you have to do is fix the faulty electrical wiring, or stamp out an errant cigarette butt, right? This is the premise you're presented with in *Eternal Threads*, but in this timeline, the blaze's casualties must be prevented with the power of kindness alone.

You are presented with a series of events that take place over the course of a week and imperceptibly add up to the tragic fire. Thankfully, you're gifted with technology that can slyly edit some of the decisions made between the house residents, ideally brewing up a butterfly effect that will get them out alive. *Eternal Threads* is a showcase of second chances, an invitation to reflect on the times in our lives when we didn't let cooler heads prevail.

There is a sci-fi veneer: you're cast as some sort of chrononaut in a dingy future, where time travel has littered the fourth dimension with all sorts of reality-eroding radiation. It's all left pretty vague, and *Eternal Threads* quickly escorts you to a house in England. From there, *Eternal Threads* takes the form of a 3D stage play starring ghostly actors. You queue up one of the scenes dotting the timeline and key into the nuances of this particular group dynamic. Occasionally, your temporal device will chime in and ask if you want to swap in an alternative climax in the action. Weave enough of these fragments together, in the correct order, and eventually everyone survives the fire.

The *Eternal Threads* format could, I think, be adapted well to a number of other settings. The scope is already so small – the whole map consists of about ten rooms and six primary characters – and it's easy to imagine it expanding further into the unruly, crisscrossing vectors of temporal fiction. I wanted *Eternal Threads* to make me feel a bit more clever than it did, but it never stopped holding my hand.

A promising time-travel mystery that doesn't quite give players a truly mind-melting temporal puzzle.

Luke Winkie

★★★½☆

OUR LADY OF SORROW

Nice place, shame about the statues.

■ Free | PC | bit.ly/OurLadySorrow

With its slow, atmospheric horror and found footage packaging, this game is evocative of that momentous year. It's set in an Irish abbey, where a witch met an untimely end centuries ago. It's not clear why you're there, but the tape of your exploits is considered so dangerous it has been locked away. Cue lots of wandering round the abbey, while things mysteriously shift around you, including statues moving while you're not looking.

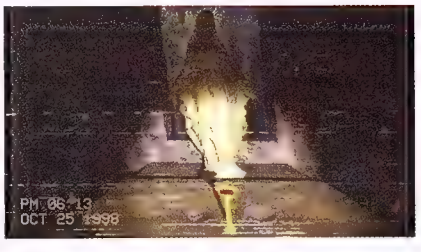
Essentially a witch cursed a priest, who retaliated by burning her at the stake and throwing her remains down the abbey well. As the witch was being burnt alive, the image of the Virgin Mary supposedly appeared on her face – and it's how she makes contact throughout the game.

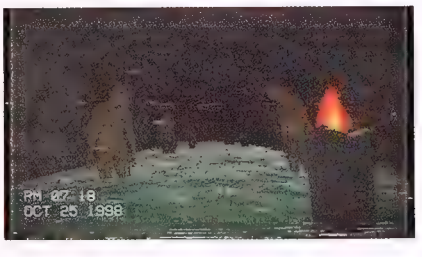
There are other statues are far more successful in creating an air of unease. They carry the game, before it reaches its ending. This is an on-point horror game that succeeds in creating a spooky atmosphere. However, it failed to convince me there's anything scary about the mother of Christ.

There's a rich atmosphere, but no real pay-off to this understated found footage horror game.

Tom Sykes

★★½☆☆





LOOPER

Going round and round.

■ Free | Browser | bit.ly/LooperGame

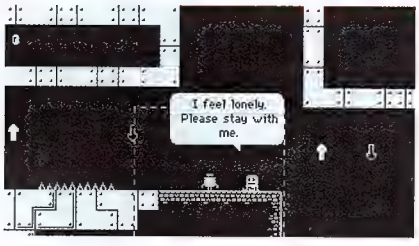
If *Looper* doesn't quite make the most of its clever premise, at least it offers a few screens' worth of smart monochrome puzzling. You play as a cute little guy and you've just learned how to fold space for your benefit.

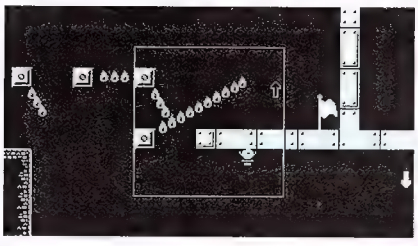
This power takes the form of a big white box that normally follows you around, but that you can freeze in place with a tap of the space bar. This makes the space inside the box loop round on itself, so that if you walk out the left side you'll pop back in on the right. It's a pretty impressive spectacle, more so given that you're in control of the box's position. It feels rewarding to use the looping power to bypass solid walls, jump clear across the screen, or collect optional coins.

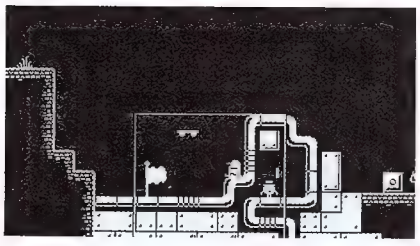
Looper, alas, is only 15 minutes long, wrapping up after barely exploring its titular mechanic. There are all the ingredients for a great puzzler here – a clever idea, attractive environments and a few good puzzles – but not the size to let that idea flourish.

The problem with a good thing is you just want a lot more of it.
Tom Sykes

★★★☆☆







SNIPER ELITE 5

Not a misfire, but it struggles to hit its mark.

■ $69.95 | PC, PS4/5, XB1/X/S | sniperelite.com

Five games deep, *Sniper Elite* delivers what I consider to be its best installment since the original. Yet a total lack of confidence in its core sniping conceit, as well as a truly dire story, drag down what should be a more enjoyable stealth game.

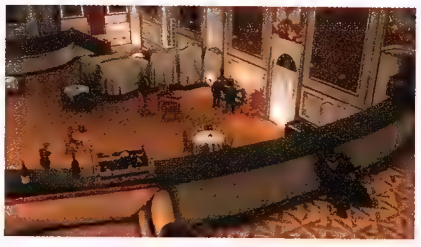
It's the Second World War through the eyes of a teenage boy. The French Resistance are present throughout, and every time they showed up I couldn't help but wonder why they weren't the star of the show. Once it finally opens up, you can at least begin to enjoy what the game does best: picking a roost and shooting bad guys from really far away. It's not open world, however much the expansive landscapes conjure up the notion. In fact, you frequently feel railroaded by the levels, with numerous invisible walls and awkward barricades. No matter how open the areas seem, they're always far more linear in practice.

Not that they're bereft of choice, and in truth the more limited scope allows the game to funnel players into interesting obstacles. Rather than picking a perfect hill and performing long distance brain surgery from safety, you're pressed into taking risks to manoeuvre around patrols and reach vantages undetected. The pay-off of a secret tunnel or climbable ledge feel earned instead of laid at your feet.

While *Sniper Elite 5*'s levels fall short of the Hitman games from which it has taken blatant influence, they nonetheless play with more than just popping heads off. While not as open as they seem, these levels are sprawling labyrinths full of little choke points and secrets worth exploiting. You can even stage 'accidents' in certain locations, though disappointingly the game's AI doesn't recognise it as such and views any death as proof a sniper is in the vicinity. But still, having various options available makes levels more fun to exploit, even if the lack of a real atmosphere or a sense these soldiers doing anything besides waiting for you to show up, means there's less thrill in your trespassing.

A quality step-up for the series that's unfortunately still rather short of stealth game greatness.
Samantha Greer

★★★☆☆



CITIZEN SLEEPER

Using dice to escape Deckard in this cyberpunk RPG.

■ $28.95 | PC, XB1/S/X, Mac, Switch | bit.ly/3x58PhC

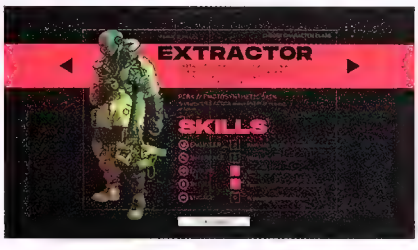
Citizen Sleeper is like *Blade Runner*, but you're the replicant on the run. A synthetic being who has escaped from the corporation that built you, you hide on a space station that's become a rogue state – home to revolutionaries, refugees, and a pirate gang. While you're worrying about whether you'll be hunted down and dramatically shot in the back, you're also worried about day-to-day survival.

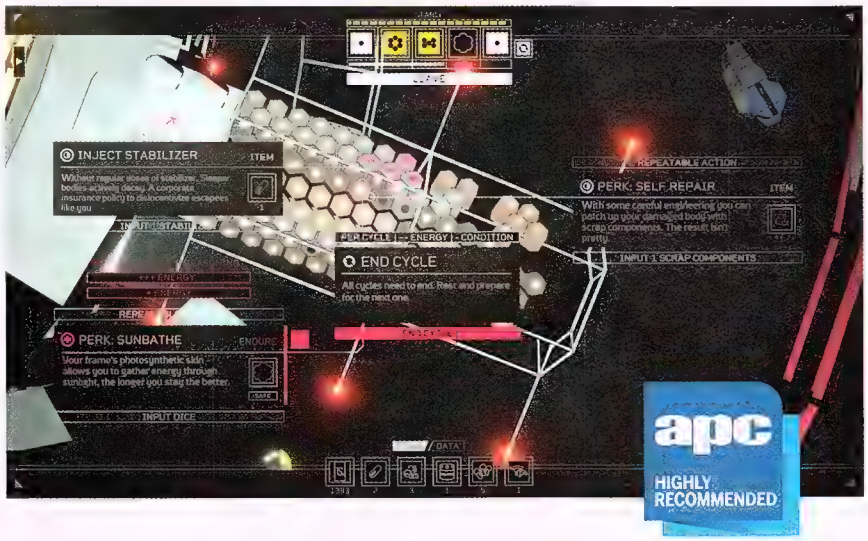
The game is great at encouraging you to live a routine. Here I lived a day-to-day cycle that included sleeping, eating, working, and feeding a stray cat. Some of it was mechanically necessary, some was pure roleplay. Every morning you roll a pool of action dice, each of which can be spent on a task, like working a shift at the shipyard or exploring a new area of the station. The higher the number, the better you'll do.

Citizen Sleeper is focused on ordinary people. Exploring the station introduces new characters, telling their stories with choice-and-consequence moments of interaction. Those stories unfold over time. The UI tells you how many cycles before their next chapter begins, so while waiting you go back to work at the bar or the farmstacks, and try not to fall apart. Thanks to planned obsolescence, your condition stat constantly decays. As it ticks down you get less dice. The stabiliser you need to refill your condition is expensive, and hard to source. You're not made to last.

Additional pressure is provided by the hunters. The corporation or their freelancers will track you down eventually, and every hack you perform gives the bestial artificial intelligence that patrols cyberspace another whiff of your scent.

The game has multiple endings, and you can continue playing to find others. By the time I was done I had freed an AI from a vending machine, foiled a couple of corporate schemes to get toeholds on the station, and renovated a bar. I didn't want to leave, and I hit the credits three times finding multiple endings in one playthrough.

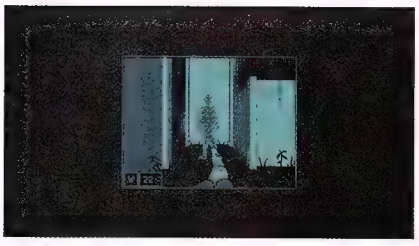




apc HIGHLY RECOMMENDED

An incredibly evocative life-sim RPG, and one that you won't want to wake up from.
Jody Macgregor

★★★★☆



OUT OF THE BLUE

Escape a puzzle maze.

■ Free | PC | bit.ly/OutBlueGame

Created for the Dungeon Crawler Jam, *Out of the Blue*'s grid-based movement evokes games like *Dungeon Master*, but with decidedly one-sided combat. It's one-sided because the enemies will just stand there until you shoot them, find another route, or suffer damage by shoving your way straight through. They're obstacles, really, just like everything else in this jungle maze, which you'll slowly best as you spiral outwards from your camp.

Out of the Blue's most prominent feature is its energy system, which counts down with every step you take. You start each run with just 32 energy, and when that runs out you wake up back at the camp, ready to take your paltry 32 steps again.

Blessedly, there are ways to increase your roaming range, including opening permanent shortcuts. There are also a few permanent upgrades that make things a whole lot easier. But these items are hard-won, after time spent scouting the environment in patches. The game is very short, however. I reckon it took me half an hour.

An enjoyable process of exploring and solving.
Tom Sykes

★★★☆☆

Turtles and rats in a sewer? Cowabunga!

GAME CHANGER

Nuclear Throne

Irradiated, bloodied, and still the best roguelike around. By Nat Clayton

■ **Release:** Dec 5, 2015 **Developer:** Vlambeer **Publisher:** In-house **Link:** nuclearthrone.com

In an instant, it all comes back. The immediate sense of danger. The strategy, the weapons, remembering to grab a grenade launcher for the 2-1 bonus round and remembering to avoid opening the gates in 3-2 and 5-2 to keep them safe for the eventual loop. I make it to the Throne at record pace, busting the generators to break into the secret second phase... and then I beef it. Melted. A promising run killed in an instant, doomed by one slip up.

I need you all to understand, I used to be hot shit at *Nuclear Throne*. Back in uni I was obsessed, making sure to get a daily run in every morning before heading to class, ill-advised subwoofer blasting the sounds of Joonas Turner's fat bassy gunshots into my neighbours' ceilings (probably). Even if I never topped the leaderboards, I was a regular sight in the top 25, frequently clawing my way into the top 10.

Because while *Nuclear Throne* was never the deepest or most strategic roguelike, it's raw, loud and incredibly satisfying, a buffet of crunchy pixelated murder where even the most successful runs can easily be crammed into a lunch break.

Throne Butt

Nuclear Throne is a 2015 twin-stick shooter by Vlambeer, the (now-defunct) crafty Dutch rascals behind equally screen-shaking games like Luftrausers and Ridiculous Fishing. It is, generously speaking, a roguelike – maps are procedurally generated on the fly, weapons are scattered across levels, levelling up grants you a choice of upgrade 'mutations' to plug into your body, and death is both quick and permanent.

But unlike a Binding of Isaac, Slay the Spire, or even Enter the Gungeon (its closest relation, mechanically speaking), *Nuclear Throne* isn't really a game about strategising builds or long-term planning. It's a roguelike played on the edge of your seat, selecting from a scant list of upgrades in a blind panic in the hopes that you're either carrying, or might find, the weapons that make it all click.

It works, because the simple act of blasting stuff in *Nuclear Throne* is joyous. Vlambeer wrote the book on game feel, and when even your piddly little starting revolver kicks up bass and punches the screen, you know you're in for a good time. The world is built up of tiles, and some weapons (explosives, particularly spicy energy weapons) will blow out chunks of these walls, while some bosses might even charge through 'em in a murderous rage.

Gene pool

Rather than synergising into weird and wonderful combos, 'mutations' tend to benefit stuff you're already doing. Better health and ammo drops, shotgun shells that bounce further, crossbow bolts with aim

Left: The Omega Weapons mod tends to get a bit silly.

Right: He's got brains and brawn.

assist, halos to grant you a second chance, each framed as another gross little mutation bursting out of your messed up little guy.

Nuclear Throne's characters are a wonderfully screwed up band of freaks, mutant fish and living crystals, and rebel bandits who turn their flesh into smaller, friendly bandits. They each have their own quirks, usually in abilities, but often in how the world responds to their presence.

YV is a floating triangle from Venus, and you're guaranteed to crash his pad on reaching level 10 to pick from a literal pile of guns, while simple ol' Fish will always get a guitar on reaching Throne 2. Rogue is on the run from her former extradimensional cop buds, and will be accosted by them from the offset – a small price to pay for being able to summon in devastating airstrikes at will.

Unlocking these characters at all is also refreshingly old school in its strangeness. There are no levelling thresholds or unlocks – and while early characters are unlocked just for reaching certain stages or beating the game, you need to get creative to find others. Horror will only show up if you avoid those tantalising rad canisters scattered about each stage.

> "A game about being a funky little guy blasting bandits and monsters"

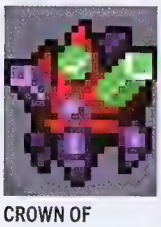
And that's really the thing about *Nuclear Throne*. It's a deceptively simple game on the surface – shoot gun, mutate, don't die, kill god's chair, easy as. But the more you poke and prod, scraping away at those wonderfully destructible walls, the more secrets you find. Hidden stages, hidden bosses, final endings and a world rooted in a more melancholic tragedy than you'd ever have suspected.

Fläshyn

Yes, *Nuclear Throne* is a game about being a funky little guy blasting

CROWNING ACHIEVEMENT

Heavy is the head that puts on one of the game-changing hats

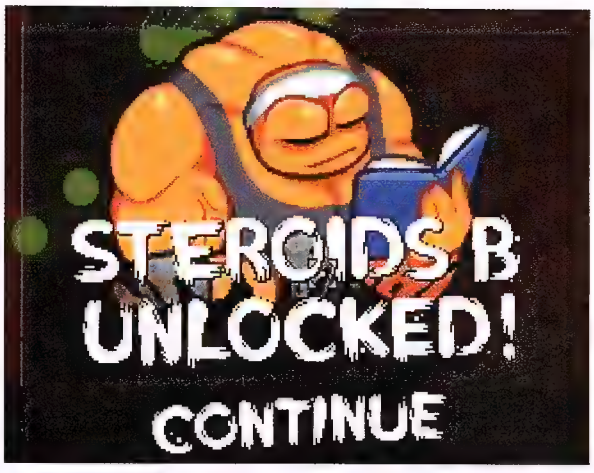


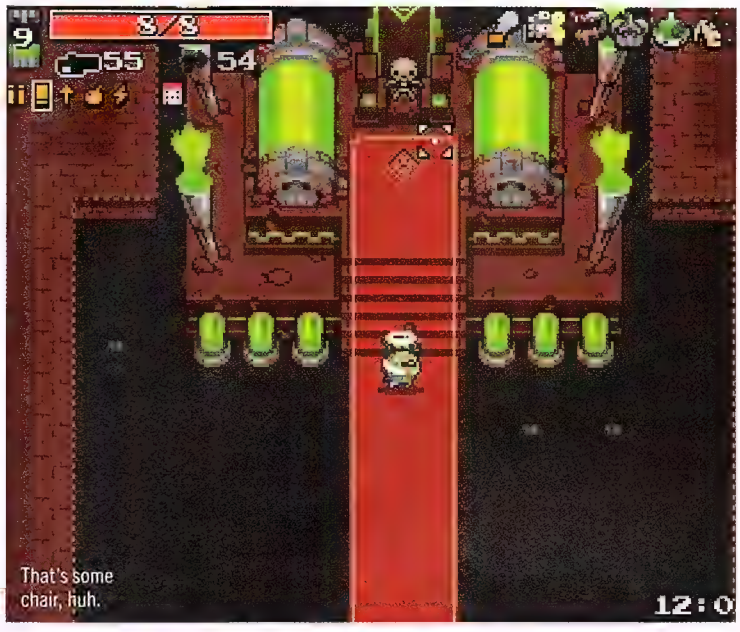
CROWN OF CURSES
Most chests are now cursed, meaning you won't be able to swap out guns stashed within until you find another cursed gun.

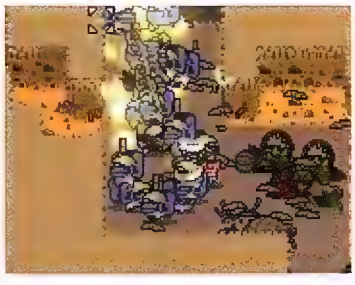
CROWN OF GUNS
Say goodbye to ammo drops, but say hello to baddies dropping blasters more frequently. Risky, but the payoff can be excellent.

CROWN OF DEATH
All explosions are now bigger, and grenade launchers will fire more grenades per shot, at the expensive of reducing your HP.

CROWN OF BLOOD
A post-loop crown that adds just so, so many more enemies to each stage. Absolutely essential for hitting those daily leaderboards.







bandits and monsters in a wasteland. But there is a truly astounding level of effort put into making this cartoon universe feel coherent and considered. There's a whole language called Trashtalk for your mutant's guttural screaming – a selection of sounds representing actions, places, and objects.

For example, did you know that at the start of your run your character will often shout "Fläshyn!", constructed of FL (do) Ä (me/we) SH (this) YN (now), loosely translating to "Let's do this!". Rhaäve'sho can be interpreted as "our lives are hard", while the Nuclear Throne itself is a sharp, choked Fläisum.

It's a level of care that grounds this goofy world of mutants and monsters enough that, when it wants to, *Nuclear Throne* can pull off moments of real melancholy. You'll often load into a map playing a more sombre piano variation of the level theme, maps feeling eerie when the dust has settled.

The run-up to the Throne itself is a masterclass in scene-setting, a just-too-long walk up a long corridor while pulled strings ring ominously. Once the fight starts, the music is a desperate howl with frontier strumming, one final effort that begs to ask whether your fight was worth the pain.

Across the board, Jukio Kallio's soundtrack hits this perfect note of post-apocalyptic western, heavy riffs settling alongside twangy guitars. The game's credits song is an all-time great, a breath of relief sung in campfire melody.

Modular Chair

Nuclear Throne, on release, was a perfectly formed thing. But that form took years to take shape, and its development was catalogued in entirety through Twitch. Vlambeer would work on the game in front of a live audience, who would then get to mess with the latest version of the game in Early Access.

In that way, *Nuclear Throne* has always belonged to the community. And in the seven years since release, the community has run wild with the game, a small but fascinating modding scene growing up around it.

The biggest of these is *Nuclear Throne Together*, which on the surface expands the game's multiplayer from couch co-op to full online lobbies of up to four players. But *Nuclear Throne Together*'s secret is that it also cracks the game wide open, acting as a foundation for *Nuclear Throne*'s wildest mods.

There are mods that add guns, mods that change guns, mods that procedurally generate guns on the fly. Mods that let you play as the Soldier from Enter the Gungeon, mods that replace every enemy with frogs, mods that slam environments into each other in a dimensional nightmare.

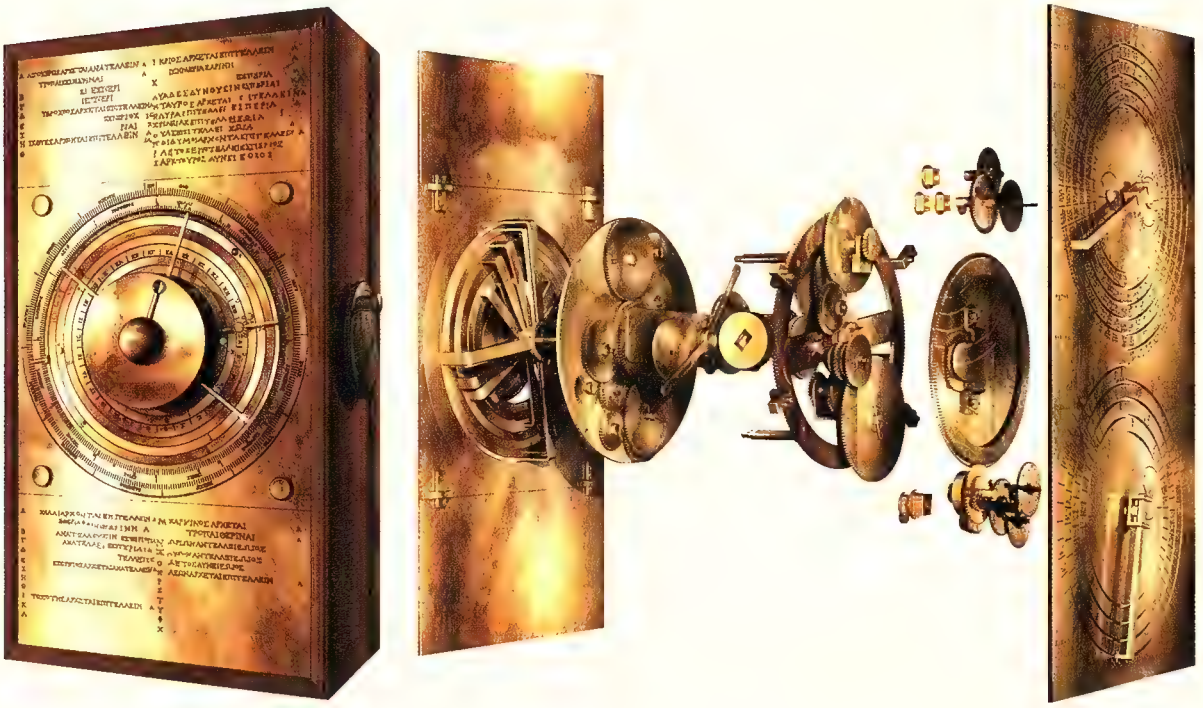
Beyond NTT, there's even a massive Community Remix mod that adds three new characters, fifty new weapons, and enough new mutations, crowns and otherwise to turn *Nuclear Throne* into something madly and wonderfully new – but never unrecognisable.

Nuclear Throne is pure, simple, chaos. Mods might turn the game on its side, deep fry it, and cram a thousand tons of explosive into it, but they never pul l the game away from the raw thrill of slamming 'play' and dropping into a desert full of bandits armed with only a revolver and heavy guitar riffs. Now, if you'll excuse me, I'm late for today's daily. Let's see if we can't actually make it back into the top 10 this time, eh? ■

RETRO

DECODING THE WORLD'S FIRST ANALOGUE COMPUTER

Discovered in a shipwreck and believed to date back to 178 BCE, the Antikythera mechanism is a 2,000-year-old mechanical computer that has kept scientists occupied for decades. David Crookes unlocks its secrets.



Building your own PC in 2022 can be intimidating, but at least it's easy to identify the parts involved. Not so for the Antikythera mechanism: scientists have been trying to recreate and understand the world's first analogue computer for the best part of 120 years. But since this curious device is over two millennia old, in bits and has two-thirds of the pieces missing, it's no wonder it's puzzled them for so long.

The Antikythera mechanism could have come straight out of an Indiana Jones film. Discovered in 1900 by Captain Dimitrios Kontos and his crew of divers near the tiny island of Antikythera, its main surprise is its sophistication. There is simply nothing else like it from the ancient world.

Among the astounded researchers is Professor Tony Freeth, of University College London. He became interested in the Antikythera mechanism about 20 years ago. "I was approached by somebody I knew through a close friend who is a professor of astronomy and he asked me if I'd heard of this thing," Freeth told us. "I hadn't but I was soon intrigued by the puzzle that nobody had ever told me about."

Above: A computer model shows how the mechanism may have worked.

Below: The device had a main drive wheel at the front to turn the gearing.

He quickly learned how diver Elias Stadiatos spotted a pile of treasure amid the bodies of long-lost humans and horses while Kontos' crew were exploring the Aegean Sea off Antikythera's coast. One of the treasures in this 60 BCE shipwreck was a piece of rock – one that was overlooked for many months in favour of more exciting finds.

In 1902, however, archeologist Valerios Stais noticed a gear wheel in the age-old rock and, three years later, a German philologist called Albert Rehm suggested the device was an astronomical calculating machine. Rehm discovered astronomical cycles in the device and saw inscriptions that showed when the stars rose and set. He reckoned all five known planets would have been displayed on the device.

Rehm also found that the numbers 19, 76 and 223 were inscribed on a fragment and realised the mechanism could also calculate the Metonic cycle; the 19-year cycle of the Moon. This was notable because Greek mathematician Kallippos had developed a cycle of four 19-year periods, giving 76, while 223 is the number of months in a Saros period, which can predict eclipses

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Above: Tony Freeth admires the Antikythera mechanism in its Athens home.

Below: Horologist David Higgon at work on the mechanism.

of the Sun and Moon.

That's where the trail seemed to end, but in the 1950s a new generation of scientists took a closer look. British historian of science and physicist Derek J de Solla Price spent 20 years studying the Antikythera mechanism, poring over X-ray and gamma ray photos taken by husband-and-wife radiologists Charalambos and Emily Karakalos. In 1974, he published a paper called "Gears from the Greeks" in the journal *Transactions of the American Philosophical Society*. It proved revolutionary.

The three researchers identified 30 distinct gears from the 82 surviving fragments of corroded bronze. Of those, 27 were in one fragment, and there was one in three other pieces. What's more, they could estimate how many teeth were on each gear wheel, and that gave clues as to how the device performed its calculations. It was a big leap, but left many questions still unanswered.

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It's all Greek

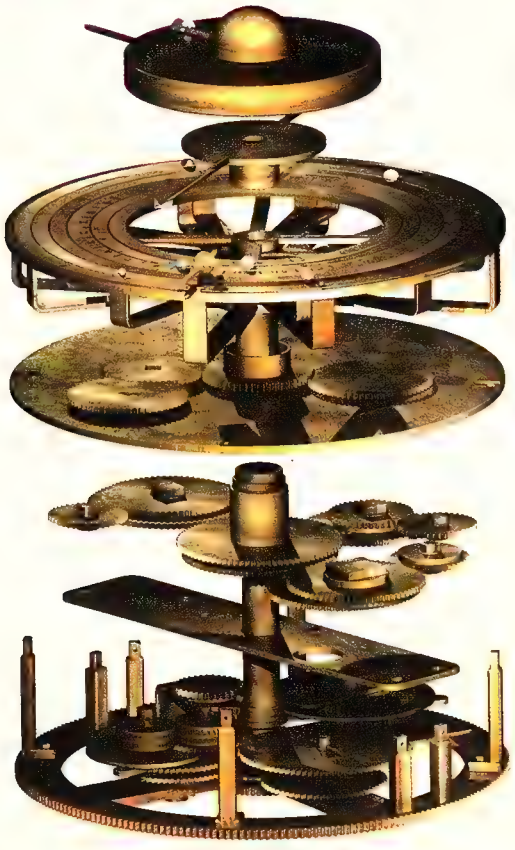
Fast-forward to 1990 when Michael Wright, a physicist, historian and Science Museum curator, worked with Australian researcher Allan Bromley and took 700 radiographs of the device using linear tomography ("an early 3D imaging technique used in the Second World War to locate shrapnel fragments in the human body," Freeth explained). This led to a fully working replica being unveiled in 2002 purporting to show the correct arrangement of the surviving internal wheels, including a large gear with 127 teeth, identified by Price.

Freeth's subsequent work has arguably had a greater impact, however. "When I heard about the Antikythera mechanism, I'd read Price's classic work and went around with my film-making team to see if TV commissioners would be interested in a programme about the device," he told us. "They said it was an old story but I remained fascinated. I also began to get very sceptical about Price's work. I just thought it was wrong. Seriously wrong."

Such a hunch spurred him into making his own investigations to unravel the mystery, together with an Anglo-Greek team of scientists. Knowing the device had been housed by the National Archaeological Museum of Athens ever since it was discovered, they spent five years persuading the authorities to allow them to properly examine the pieces. Freeth then asked UK company X-Tek Systems to carry out CT scans on the fragments – the most sophisticated, non-destructive way of delving deep inside the Antikythera mechanism.

"The company built a special prototype machine in 2005 and we gathered data over two-and-a-half to three weeks," Freeth explained. "At the same time, I found that Hewlett-Packard had a digital imaging system that could look at the surface of the mechanism using a technique called polynomial texture mapping and it could examine the inscriptions, which are very hard to read. Once we had all of this data back, we could work out how the thing

Image of CPC 464; Credit: Bill Bertram, Wikimedia Commons, CC BY-SA 2.5



Above: It's a mystery how the Greeks manufactured the complex gears.

worked." The results were astounding.

"The X-ray CT data found inscriptions inside the fragments that were completely hidden from the surface," Freeth said. "They were not shown at all by the 2D X-rays that had previously been carried out because they'd just blasted through the fragments. We found thousands of new text characters inside the fragments, and they were very important because the inscriptions described how the mechanism worked. It was painstaking because we had to go up and down through the CT slices to determine what a character was, but we saw a calendar dial on one fragment, for instance, with the month names on it."

More than that, the gears began to be seen more clearly. Towards the back of the mechanism was a 223-tooth gear that fitted the inscription Rehm had discovered. Freeth says there were four gears within its circumference that, it transpired, calculated the variable motion of the moon. There was also evidence of a Saros dial, split into 223 sections, that would predict which months would feature an eclipse. It was part of a system that turned a pointer round the Saros eclipse prediction dial.

"The fact that it could predict eclipses had been hinted at before by Price but rejected," Freeth said. "Price had considered it in 'Gears from The Greeks', but he was great at having good ideas and throwing them away in favour of more simplistic ideas."

Stepping up a gear

Slowly but surely, Freeth pieced together the workings of the back of the machine. The 223-tooth gear would turn slowly, carrying the two epicyclically mounted gears in the four-gear system at the back, which would turn the pointer for the variable Moon. This system depended on a pin-and-slot device to generate the variable motion of the Moon, which had been observed by Wright, but not understood and then rejected.

Now research had found a second role for the large gear in modelling the subtle variable motion of the Moon. Freeth's focus then turned to the front of the mechanism where, it was noted, there was a main drive wheel with four spokes on the largest fragment that would rotate once annually.

Wright had also tackled the mystery of the front mechanism, devising a complex system featuring eight co-axial outputs. He was convinced the front was a planetarium that had a hand for each of the five known planets – Mercury, Venus, Mars, Jupiter and Saturn – moving around a Zodiac circle. It took into account that the planets, viewed from Earth, primarily move East to West but sometimes reverse their motion to West to East. In modern terms, this is because the planets go round the Sun and we are viewing them from the Earth. But (for the most part) the ancient Greeks did not know this and developed a theory that attributed their motions to the sum of two simple circular motions.

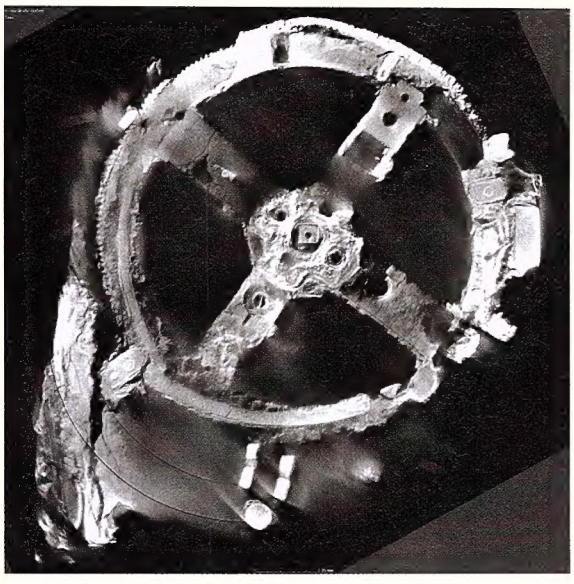
Freeth and his team took Wright's work as the basis for further research, but they also drew upon a finding in 2016 by Alexander Jones, a professor of the history of astronomy at New York University. Two numbers were apparent in the X-rays of the front cover – 462 and 442 – each representing the number of years of the cycles of Venus and Saturn. This was amazing in itself – how did the Greeks reach such an accurate figure?

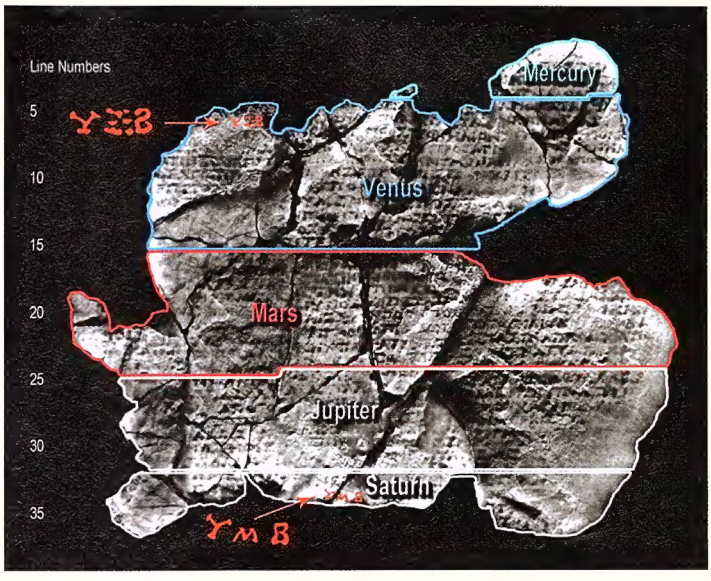
By using the ancient Greek mathematical method described by philosopher Parmenides, however, Freeth and his team at University College London were able to work it out, along with the cycles for Mercury, Mars and Jupiter.

"We created a computer model," said Freeth, whose brilliant team included materials scientist Adam Wojcik, horologist David Higgon, archaeometallurgist Myrto Georgakopoulou, imaging specialist Lindsay MacDonald and physicist Aris Dacanalis.

Together they worked out a new gear arrangement, one that moves the celestial bodies in the correct manner on concentric rings. Part of the puzzle was creating the parts to fit into a space just 25mm deep; they also had to remember that the ancient Greeks believed the Sun and planets revolved around the Earth – something which made the mechanism more complex than if it was depicting the bodies revolving around the Sun, as we now know to be the case.

Right: The FRAMe Project has reconstructed the mechanics.





Above left: High-res X-ray images revealed previously unseen details.
Above: Front cover inscriptions are shown via a CT scan.

The next step is working out whether the ancient Greeks physically created the mechanism in the proposed manner using the techniques of the day. They certainly didn't have a lathe to shape the metal, so how did they manage to create the components? As Dr Wojcik has pointed out, one challenge has been the system of nested tubes that carried the astronomical outputs. "It's quite remarkable how the device works – astonishing, extremely clever, breathtaking actually," Freeth said.

Lost to time

Even so, there is a sense of frustration. While there is great enjoyment to be had in better understanding how the device was able to predict the positions of the Sun, Moon and planets as well as lunar and solar eclipses, Freeth believes that some of the work could have been avoided had more care been taken of the mechanism in the earlier years.

"It's so difficult to study because it's in pieces, although it must have come out of the sea in one piece – they couldn't possibly have had a diver picking pieces from the sea floor and putting them all together because they wouldn't have known how to do this. They're just like lumps of rock with few surface features," he said.

"The museum doesn't offer a lot of information about what happened after it was found, but there are some details of conservation work being carried out. There is also evidence that one researcher used a little stick to scrape bits off the inscription, since there were no non-destructive ways of looking at it."

Freeth points to early photographs of the Antikythera mechanism by way of proof that the material had diminished over time. "Take Fragment C, which is one of the main fragments," he said. "It had the front cover plate removed – Fragment G – which was taken off in bits and pieced back together. I don't think anyone quite knows exactly what happened, but museums in those days would take interesting objects, scrape off the surface secretions to produce a beautiful object but end up scraping away evidence."

Thankfully, enough has remained intact for this great 3D puzzle to be tackled, with further research yet to be carried out. Aristeidis Voulgaris at the Thessaloniki Directorate of Culture and Tourism in Greece suggested the starting date for the device is 22 December 178 BCE, which he calculated by taking into account the 223 months it takes for the Sun, Moon and Earth to return to their relative positions.

Voulgaris noted that the astronomer Geminos, who was active around 50 BCE, referred to the start of the Saros period when the New Moon is located at Apogee – its furthest spot in its orbit from Earth – and at the beginning of the Draconic cycle (the Node/Ecliptic zone). "A New Moon at the Node/Ecliptic means a solar eclipse and a New Moon at Apogee means that the angular diameter of the Moon, during eclipse, is small and the lunar angular velocity is the lowest," Voulgaris said.

"Therefore, Saros starts with a solar eclipse which is annular and has a very large duration, so we tried to find annular solar eclipses with a very large duration between 300 BCE and 100 AD. By using NASA's eclipse catalogues, we found three annular solar eclipses with extremely long central duration and one – 22 December 178 BCE – is directly correlated to the mechanism's epoch."

Problems and solutions

The mystery of the Antikythera mechanism is far from solved. Professor Tony Freeth believes the evidence stacks up in favour of the device having been based on a design by ancient Greek mathematician and inventor Archimedes. It could also mean the Antikythera mechanism is only one of many examples, some of which may still be discoverable (Archimedes died in 212 BCE, giving an idea of when it was invented).

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Freeth will continue to work on the project. Having overseen the creation of innovative mechanisms with his team, he's keen to determine their feasibility. "The thing that keeps you going is that the data throws up these difficult puzzles but there are solutions to the puzzles," he said. "It may take months or years to actually understand it, but you do get those moments." ■

Image: Tony Freeth – Mechanism: X-ray CT of Fragment A: X-ray CT of Fragment G – Front cover

CHIP CHAT

APC REPORTS ON THE UNUSUAL SIDE OF TECH NEWS

ALL THE GOBLIN ASS NFTs GOT PINCHED

Another NFT project goes arse up.

While the whole of the crypto space is a bit of a tragedy right now, perhaps the biggest mess is that someone stole all the Goblin Ass NFTs before they could even get one cheek off the ground. Goblin Ass, a spinoff of the hugely and inexplicably popular GoblinTown NFTs, was really just riding on the coattails of its inspiration. The team behind it drew the entire green butt collection in an evening and attempted to get it functional on OpenSea in just three days. Unfortunately, the whole project was uploaded to a publicly available OpenSea platform to test it prior to launch, which allowed someone to steal all the art and mint their own fake Goblin Ass NFTs before the creators could let rip.

18-YEAR-OLD MATHS WIZARD TRICKS DE-FI PLATFORM INTO GIVING HIM US$16 MILLION

Accelerated graduate student exploits vulnerability in blockchain contracts to steal a fortune.

In October of 2021, the promising decentralised finance software Indexed Finance experienced a set of trades on the platform that used US$157 million worth of cryptocurrency tokens to manipulate the value of assets on the platform in order to syphon off around US$16 million worth of cryptocurrency. The exploit was traced to a recent collaborator, UmbralUpsilon, who was eventually identified as Andean Medjedovic, a masters of mathematics graduate from the University of Waterloo in Ontario, Canada. According to *Bloomberg*, Medjedovic had finished high school at 14 and was only 18 at the time, despite being contracted by Indexed Finance to build trading bots for them.

CHIP CHAT

The Bored Ape that Seth Green made a show about got stolen

It only cost him 165ETH to get his main character back.

The actor known mostly for his role as the spawn of Dr. Evil and the writer of the *Robot Chicken* series, was set to release the trailer for a new TV show based on one of the Bored Ape Yacht Club characters he bought, when the premium NFT was 'kidnapped' in a phishing scam. Seth now faced plummeting NFT values along with a bomb underneath a new TV show. The actual ownership of the Bored Ape copyright and NFT would be transferred with the sale of the token, but it's an untested legal theory that could've created royalty issues, so Green purchased the Ape back for 165 Ether (about US$300K at the time) from a third party that bought the NFT from the scammer. NFTs, eh?

ENGINEER BUILDS MINI LEGO COMPUTER TO PLAY *DOOM*

Lego terminal surpasses critical processor milestone.

We thought we'd finally reached the point where *Doom* had already been run on everything in the universe, but it seems that someone had yet to realise the idea of running *Doom* on a transparent Lego block. When we say a Lego block, what we mean is a custom-built circuit with a Cortex Mo processor, 4K RAM module, 16k of flash memory and a micro 0.42-inch OLED display that engineer James Brown folded into a self-built imitation Lego block. The device runs on existing Lego power blocks and while it's cool that you can play *Doom* on it, by the looks of things you probably wouldn't really want to.

James Brown
@ancient_james
I wired the brick up as a very small external monitor, so you can, for instance, play Doom on it.
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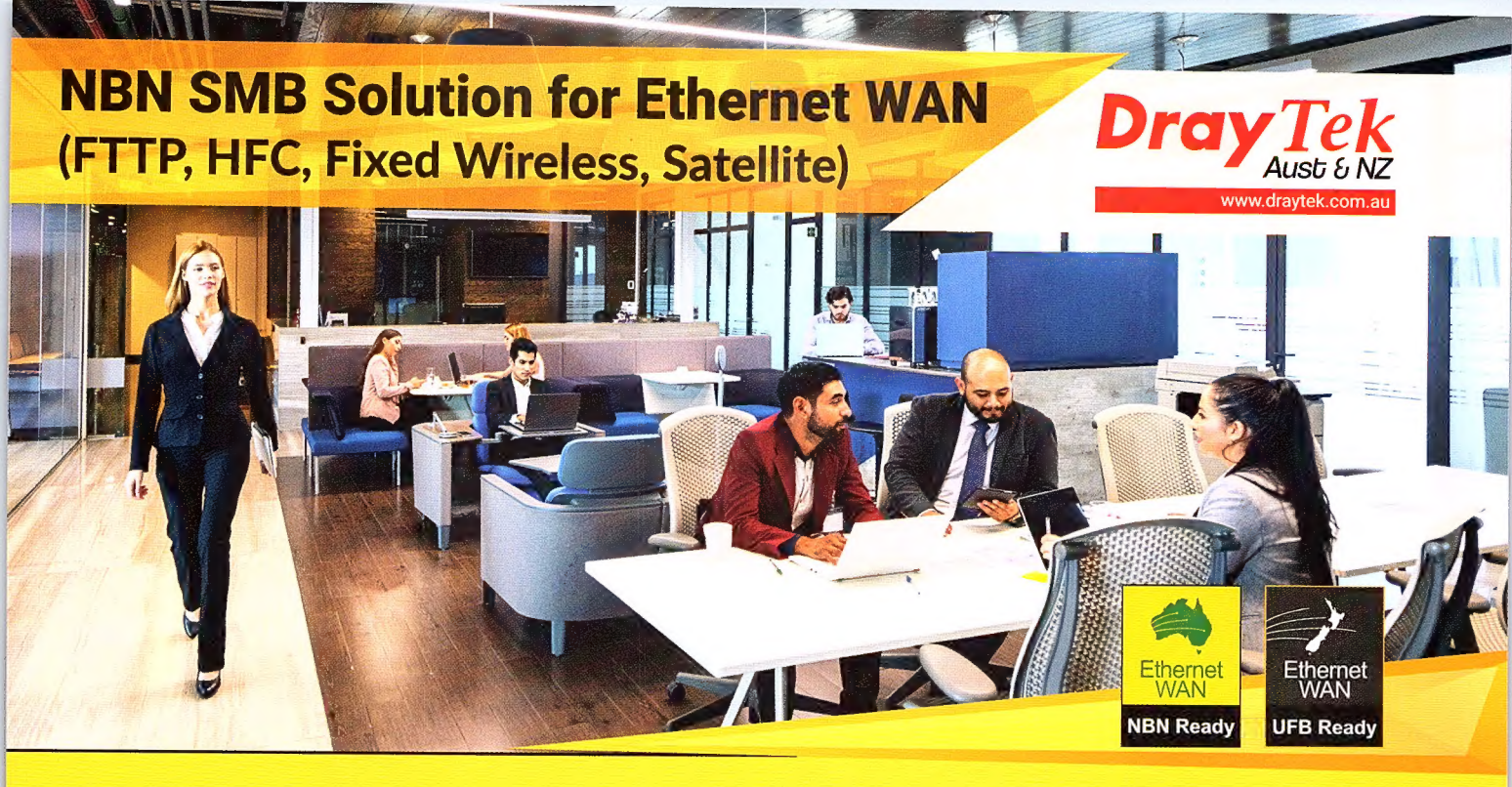

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